LRFD

Section 3.30

New: April 2005

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3.30.1 General

1.1 Material Properties

Concrete

LRFD Table 3.5.1.1 Unit weight of reinforced concrete, γ_c = 150 lb/ft^3

Concrete Slab on Girders shall consist of:

Class B-2 Concrete f'_c =4.0 ksi

n = 8

LRFD 5.4.2.4 Concrete modulus of elasticity, $E_c = 33000\ W_c^{1.5}\sqrt{f'_c}$

Where:

W_c = Unit weight of non-reinforced concrete = 0.145 kcf

LRFD 5.4.2.6 Modulus of rupture:

For minimum reinforcement, $f_r = 0.37\ \sqrt{f'_c}$

For deflection, camber and distribution reinforcement $f_r = 0.24\ \sqrt{f'_c}$

Safety Barrier Curbs

Safety Barrier Curbs shall consist of:

Class B-1 Concrete f'_c =4.0 ksi

n = 8

Median Barrier Curbs

Median Barrier Curbs shall consist of:

Class B-1 Concrete f'_c =4.0 ksi

n = 8

Future Wearing Surface

LRFD Table 3.5.1.1 Unit weight of future wearing surface, γ_{fws} = 140 lb/ft^3

Reinforcing steel

Minimum yield strength, f_y = 60.0 ksi

Steel modulus of elasticity E_s = 29000 ksi

1.2 Limit States and Load Factors

In general, each component shall satisfy the following equation:

LRFD 1.3.2.1

Q = $\sum \eta_i \gamma_i Q_i \leq \phi R_n = R_r$

Where:

Q = Total factored force effect
Q_i = Force effect
η_i = Load modifier
γ_i = Load factor
ϕ = Resistance factor
R_n = Nominal resistance
R_r = Factored resistance

LRFD 9.5

Limit States

The following limit states shall be considered for slab interior and overhang design:

For slab interior design: *STRENGTH – I*
*SERVICE – I**

For slab overhang design: *EXTREME EVENT – II*
STRENGTH – I
*SERVICE – I**

LRFD 5.5.2 & 5.7.3.4

*Of deformation, cracking, and concrete stresses, only cracking need be considered here.

LRFD 5.5.3.1 & 9.5.3

FATIGUE limit state need not be investigated for concrete decks in multi-girder bridges due to observed performance and laboratory testing.

Resistance factors

LRFD 5.5.4.2.1

For *STRENGTH* limit state,

Flexure and tension of reinforced concrete, ϕ = 0.90
Shear and torsion, ϕ = 0.90

LRFD 1.3.2.1

For all other limit states, ϕ = 1.00

LRFD 1.3.2.1

Load Modifiers

For loads for which a maximum value of load factor is appropriate:

$\eta = (\eta_I \eta_R \eta_D) \geq 0.95$

For loads for which a minimum value of load factor is appropriate:

$\eta = 1 / (\eta_I \ \eta_R \ \eta_D) \leq 1.0$

Where:

LRFD 1.3.3 η_D = Factor relating to ductility

LRFD 1.3.4 η_R = Factor relating to redundancy

LRFD 1.3.5 η_I = Factor relating to operational importance

Table 3.30.1.1 Load modifiers

	STRENGTH (slab overhang)	*STRENGTH* (slab interior)	All other Limit States
Ductility, η_D	1.0	1.0	1.0
Redundancy, η_R	1.0	1.0	1.0
Operational importance, η_I	1.0	1.0	1.0
$\eta = (\eta_I \ \eta_R \ \eta_D)$	1.0	1.0	1.0
$\eta = 1 / (\eta_I \ \eta_R \ \eta_D)$	1.0	1.0	1.0

1.3 Loads

Permanent (Dead) Loads

LRFD 3.5.1

Permanent loads include the following:

Slab weight

Future Wearing Surface
A 3" thick future wearing surface (35psf) shall be considered on the roadway.

Safety Barrier Curb (SBC)
For slab overhang design, assume the weight of the SBC acts at the centroid of the SBC.

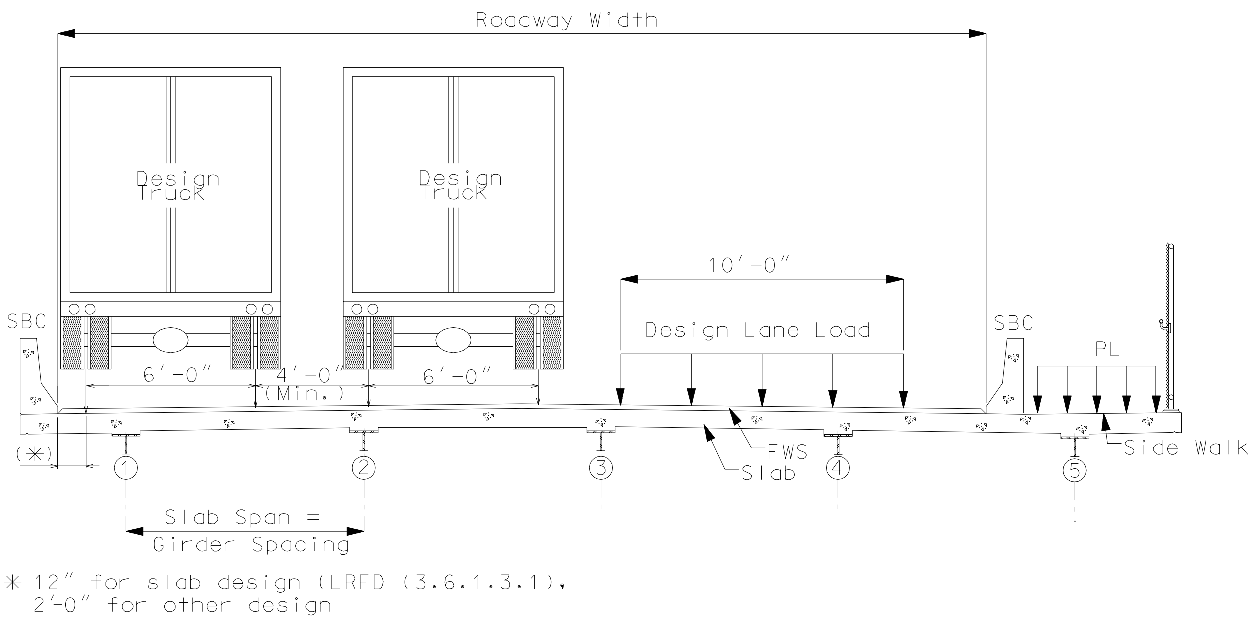


Figure 3.30.1.1 Application of Live Load to Slab

Gravity Live Loads
Gravity live loads include vehicular, dynamic load allowance, and pedestrian loads.

LRFD 3.6.1.2

Vehicular
The design vehicular live load HL-93 shall be used. It consists of either the design truck or a combination of design truck and design lane load.

LRFD 3.6.1.3.3

For slab design, where the equivalent strip method is used, the force effects shall be determined on the following basis:

- Where primary strips are transverse the design shall be based on the truck alone.

- Where primary strips are transverse and their span exceeds 15 ft – the design shall be based on the truck and lane load.

LRFD 3.6.1.2.4

For the purpose of slab design, the lane load consists of a load equal to 64 psf uniformly distributed over 10 feet in the transverse direction.

LRFD 3.6.2.1

Dynamic Load Allowance

The dynamic load allowance replaces the effect of impact used in AASHTO Standard Specifications. It accounts for wheel load impact from moving vehicles. For slabs, the static effect of the vehicle live load shall be increased by the percentage specified in Table below.

LRFD Table 3.6.2.1-1

Table 3.30.1.2 – Dynamic Load Allowance, *IM*

Slab Component	*IM*
Deck Joints – All Limit States	75%
All Other Limit States	33%

The factor to be applied to the static load shall be taken as:

$$\left(1 + IM\right)$$

The dynamic load allowance is not to be applied to pedestrian or design lane loads.

LRFD Table 3.6.1.1.2-1

Multiple Presence Factor, m:

The multiple presence factor accounts for the probability for multiple trucks passing over a multilane bridge simultaneously.

m = 1.20 for 1 Loaded Lane
1.00 for 2 Loaded Lanes
0.85 for 3 Loaded Lanes
0.65 for more than 3 Loaded Lanes

Pedestrian

LRFD 3.6.1.6

Pedestrian live load on sidewalks greater than 2 ft wide shall be:

PL = 0.075 ksf

This does not include bridges designed exclusively for pedestrians or bicycles.

LRFD A13.4.2, A13.2

Collision Loads

Collision loads applied to the safety barrier curb (SBC) shall be transferred to the slab overhang. The design forces from SBC consist of lateral and vertical components that are to be considered separately. Because of MoDOT's experience with the collision survivability of bridge decks that utilize the standard barriers given in LRFD DG Sec. 3.32, MoDOT does not require the deck overhang to be designed for forces in excess of those resulting from the design loads for Traffic Railings shown in LRFD Table A13.2-1. The standard slab cross-sections presented in LRFD DG Sec. 3.30.1.7 reflect this design philosophy.

Design Case 1

The collision force and moment shall be considered.

Slab Overhang Design Collision Moment

The design collision moment at the base of the curb is the barrier curb moment capacity about the curb longitudinal axis. For SBC design with either failure mechanism 1 or 2 controlling:

$M_{ct} = M_c$ *(averaged over height of SBC)*

Slab Overhang Design Collision Force

A refined analysis may be preformed. In this case the design collision moment at the base of the curb, M_{ct}, is to be taken as the average moment over the theoretical distribution length (L_c+2H for continuous sections), when the TL-4 collision load is applied to the top of the curb. (Refer to LRFD DG Sec. 3.32)

LRFD A13.4.2

For continuous sections of safety barrier curbs:

$$T = \frac{R_w}{L_c + 2H}$$

Where:

R_w = total transverse resistance of curb (k)
L_c = critical length of yield line failure pattern (ft)
H = height of curb (ft)
T = tensile force per unit of deck length at base of curb (k/ft)

For discontinuous safety barrier curb sections:

$$T = \frac{R_w}{L_c + H}$$

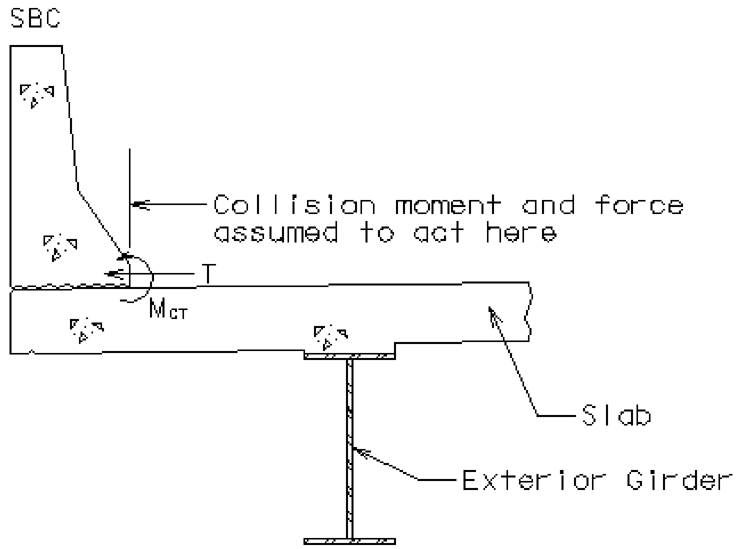


Figure 3.30.1.2a Transfer of Safety Barrier Curb Collision Forces

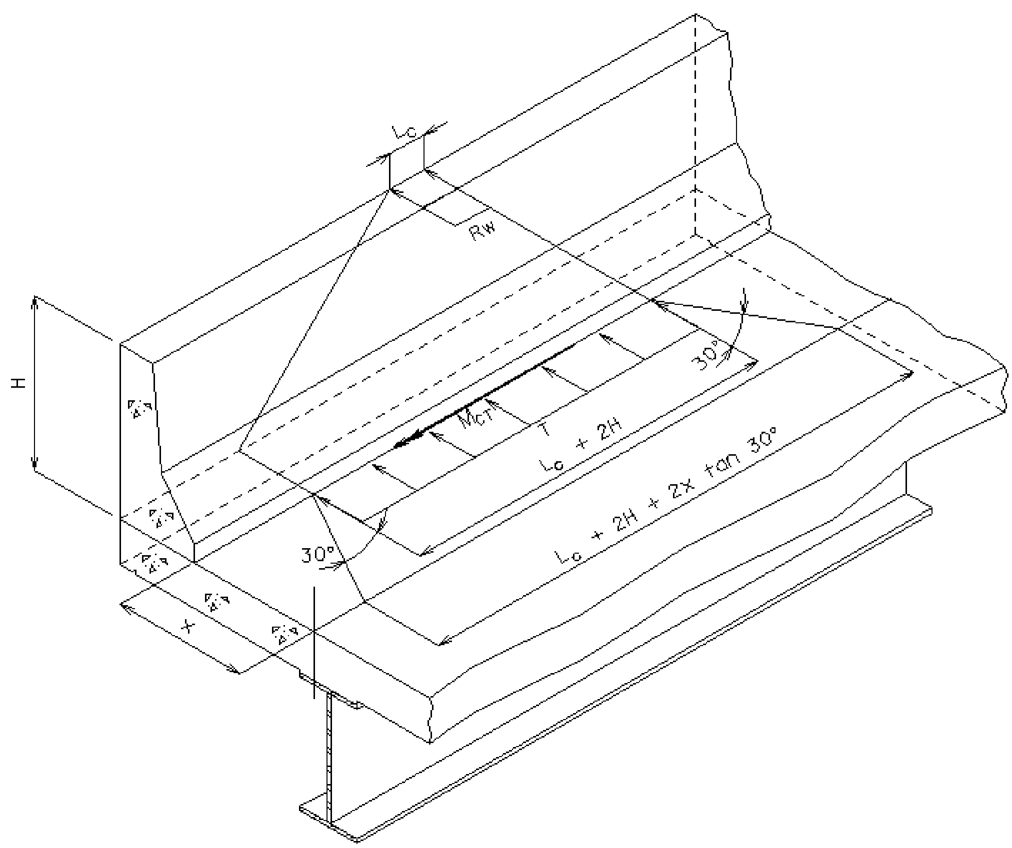


Figure 3.30.1.2b Transfer of Safety Barrier Curb Collision Forces

1.4 Design and Analysis Methods

LRFD 4.6.2.1

Equivalent Strip Method

The equivalent strip method is an approximate method of analysis in which the reinforcing steel is designed using a certain width of deck to resist the applied loading. Where the strip method is used, the extreme positive moment in any slab section between girders shall be taken to apply to all positive moment regions, and similarly with extreme negative moments.

LRFD 4.4

There are other methods of analysis allowed, such as finite element method, but the equivalent strip method is recommended.

1.5 Interior Section Design

Slab Thickness

LRFD 9.7.1.1

The slab portion between girders shall be 8 1/2" thick for both the C.I.P. and precast panel options. Precast panel option is preferred when allowed.

Design Cases

Two design cases shall be considered for each design condition.

Design Case 1 *STRENGTH I* load combination for reinforcing design.

Design Case 2 *SERVICE I* load combination for cracking check.

Design Conditions

Two design conditions can exist for the slab interior.

Design Condition 1 – Continuous Slab, where the slab section under consideration is not near an end bent or expansion joint.

Design Condition 2 – Discontinuous Slab, where the slab section under consideration is at an end bent or expansion joint.

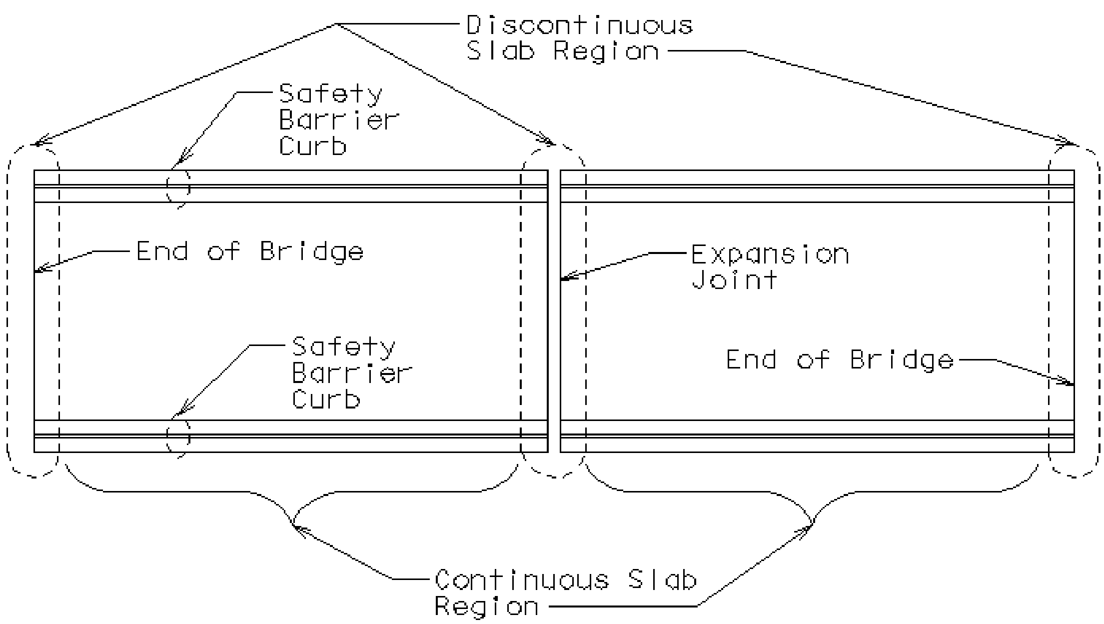


Figure 3.30.1.3 Plan View of Bridge Showing Continuous and Discontinuous Slab Regions

Critical Sections

LRFD 4.6.2.1.6

The critical design section for negative moments may be taken as follows:

For steel girders – the design negative moment should be taken at 1/4 of the flange width from the centerline of the web.

For P/S-I girders - the design negative moment should be taken at 1/3 of the flange width, but not exceeding 15" from the centerline of the web

The critical design slab section for positive moment shall be taken at location of maximum positive moment – generally midway between girders.

LRFD Table 4.6.2.1.3-1

Width of Equivalent Strip at Continuous Slab Section ($E_{cont.}$)

For Positive Moment $E = 26.0 + 6.6S$

For Negative Moment $E = 48.0 + 3.0S$

Where:

E = equivalent strip width (in)

S = spacing of centerline to centerline of supporting components (ft)

LRFD 4.6.2.1.4a &
LRFD 4.6.2.1.4c

Width of Equivalent Strip at Discontinuous Slab Section ($E_{discont.}$)

The effective strip width shall be taken as ½ of the equivalent strip width for a continuous slab section plus the distance between the transverse edge of slab and the edge beam (if any).

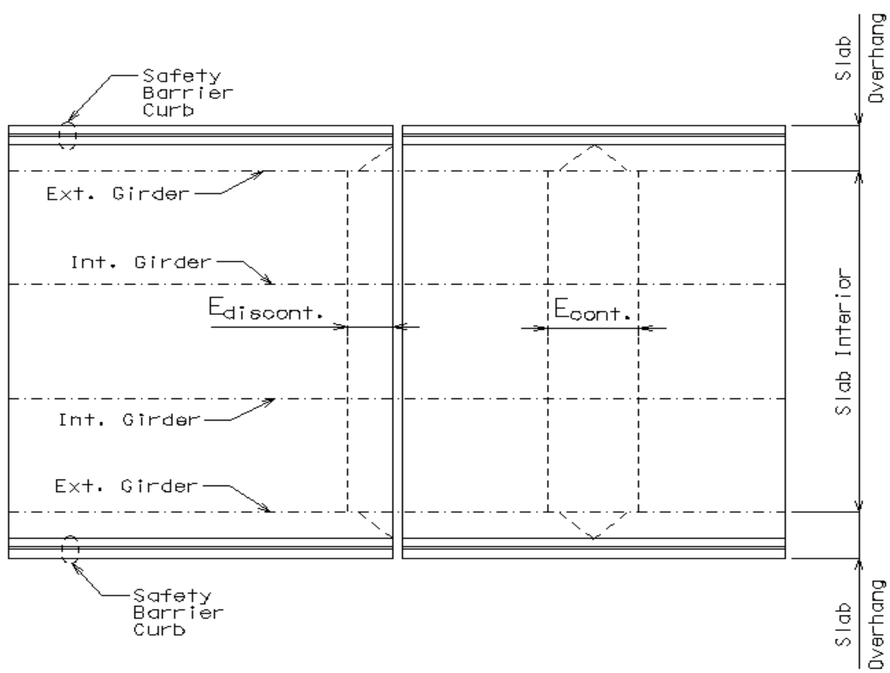


Figure 3.30.1.4 Plan View of Bridge Showing Equivalent Strip Width for Continuous and Discontinuous Slab Sections

Determining Live Load

LRFD Table A4-1

Slab interior live load design moments may be determined using Appendix Table A4-1 of the LRFD Specifications, provided that the assumptions used in the table are appropriate. It is assumed that the table is only applicable to continuous sections of slab (not at joints). It may be used at discontinuous sections by adjusting the tabulated moments as follows:

$$M_{LL+IM-discont.} = M_{LL+IM-cont.}\left(\frac{IM_{discont.}}{IM_{cont.}}\right)\left(\frac{E_{discont.}}{E_{cont.}}\right)$$

Where:
E = equivalent strip width (in).
IM = vehicular dynamic load allowance.

Note: $M_{LL+IM\text{ - }cont.}$ includes multiple presence factor, *m*.

Alternatively, the designer may use other sources to determine the design moments. For example any capable computer program for finite element design may be used.

The general methodology for applying live load to slab on girder with transverse primary strips is:

1. Model the bridge cross section.
2. Define the design vehicle (design truck).
3. Move the design vehicle between the barrier curbs and add additional design vehicles as required to produce the maximum force effect. The wheel load shall not be closer than 1 ft. to the face of safety barrier curb and wheel loads of adjacent design vehicles shall not be closer than 4 ft. The design lane is assumed to occupy a 10 ft. width. Partial trucks (i.e. one wheel) should not be used.

Determining Dead Load

Although P/S Panel option is the standard for construction (when allowed), it may be assumed for slab analysis that slab is cast-in-place (CIP). The maximum negative and positive dead load moment may be taken to be:

Continuous over 4 girders (equally spaced):

$$M_{DL} = \mp \max \begin{Bmatrix} 0.100wl^2 \\ 0.025wl^2 + \dfrac{M_{overhang}}{5} \end{Bmatrix}$$

Continuous over 5 girders (equally spaced):

$$M_{DL} = \mp \max \begin{Bmatrix} 0.107wl^2 \\ 0.071wl^2 + \dfrac{M_{overhang}}{7} \end{Bmatrix}$$

Where:
$M_{overhang}$ = moment at centerline of exterior girder due to: slab, future wearing surface, SBC, sidewalk, and other dead load components
l = center-to-center girder spacing

Determining Top Reinforcing
The top (negative) reinforcing steel may be determined by assuming the section to be either singly- or doubly-reinforced, as needed.

Determining Bottom Reinforcing
The bottom (positive) reinforcing steel may be determined by assuming the section to be either singly- or doubly-reinforced, as needed. A 1" wearing surface shall be removed from the effective depth, *d*.

LRFD 5.7.3.3.1

Maximum Limit of Reinforcement
The limit of reinforcing is controlled by the following ratio. It replaces the reinforcement ratio, ρ, requirement of other codes. If this ratio is exceeded, the section is said to be over-reinforced, which is not permitted.

$$\frac{c}{d_e} \leq 0.42$$

Where:
c = the distance from the extreme compression fiber to the neutral axis (in)
d_e = effective depth from the extreme compression fiber to the centroid of the tension force in the tension reinforcement (in). For sections without prestressing, $d_e = d$.

This limit applies to both doubly- and singly-reinforced sections.

LRFD 5.7.3.3.2

Minimum Limit of Reinforcement
The amount of tension reinforcement shall be adequate to develop a factored flexural resistance, M_r, a least equal to the lesser of either:

LRFD 5.4.2.6

1) 1.2 times the cracking strength determined on the basis of elastic stress distribution and the modulus of rupture, f_r, of the concrete.

2) 1.33 times the factored moment required by the applicable strength load combinations specified in *LRFD Table 3.4.1-1*

LRFD 5.10.8

Shrinkage and Temperature Reinforcement
The area of reinforcing for top longitudinal steel, A_s, shall not be less than:

$$A_s \geq \frac{0.11 A_g}{f_y}$$

LRFD 5.10.8.2

Where:
A_s = area of top longitudinal reinforcement
A_g = gross area of slab section (in^2)

LRFD 5.10.8.2

Maximum spacing of longitudinal reinforcement =

$$\min.\text{of} \begin{Bmatrix} 18\,in \\ 3 \times slab\ thickness \end{Bmatrix}$$

In keeping with current practice, #5 @ 15” will be used for standard slabs.

Distribution Reinforcement
The bottom longitudinal steel, as a percentage of the bottom primary reinforcement, shall not be less than:

$$\frac{220}{\sqrt{S}} \leq 67\%$$

LRFD 9.7.3.2

Where:
S = effective span length (ft) specified in *LRFD 9.7.2.3.* It is the distance between flange tips, plus the flange overhang, taken as the distance from extreme flange tip to the face of the web.

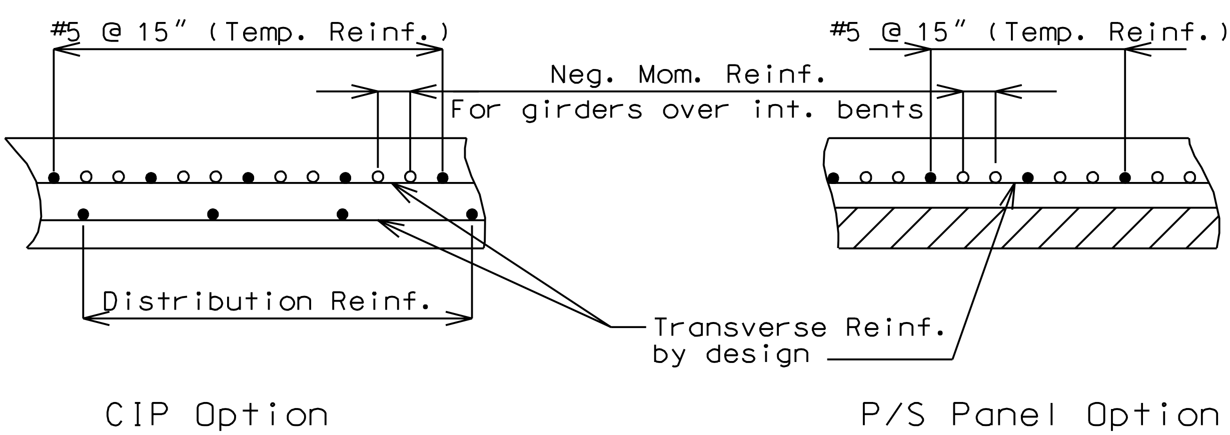


Figure 3.30.1.5 Transverse Slab Interior Sections Showing Temperature and Distribution Reinforcing

Concrete Cover

Existing (pre-LRFD) MoDOT concrete cover requirements for bridge slabs will be retained here. The cover requirements that follow meet or exceed LRFD requirements.

At Bottom of CIP slabs	1.00 in
Bottom of CIP slab over P/S P/C panels	1.00 in
Top reinforcing	3.00 in preferred
	2.75 in absolute min.

Spacing Limits

LRFD 5.10.3.1.1

Minimum clear spacing between parallel bars in a layer:
Maximum of: 1) $1.5d_b$ where d_b is bar diameter (in)
2) 1.5 times maximum aggregate size*
3) 1.5 in

* see Missouri Standard Specifications for Highway Construction

Bar Development

LRFD 5.11.1.1

The calculated force effects in reinforcement shall be developed on each side of the critical section.

LRFD 5.7.3.4

Cracking Check

Actual Stress

A transformed cracked section analysis shall be used with *SERVICE-I* moments to determine actual stress in reinforcing.

The spacing of mild steel reinforcement in the layer closest to the tension face shall satisfy the following:

$$s \leq \frac{700\gamma_e}{\beta_s f_s} - 2d_c$$

in which:

$$\beta_s = 1 + \frac{d_c}{0.7(h - d_c)}$$

where:

γ_e = exposure factor
= .75 for class 2 exposure condition.

d_c = actual thickness of concrete cover measured from extreme tension fiber to center of the flexural reinforcement located closest thereto (in)

f_s = tensile stress in steel reinforcement at the service limit state (ksi)

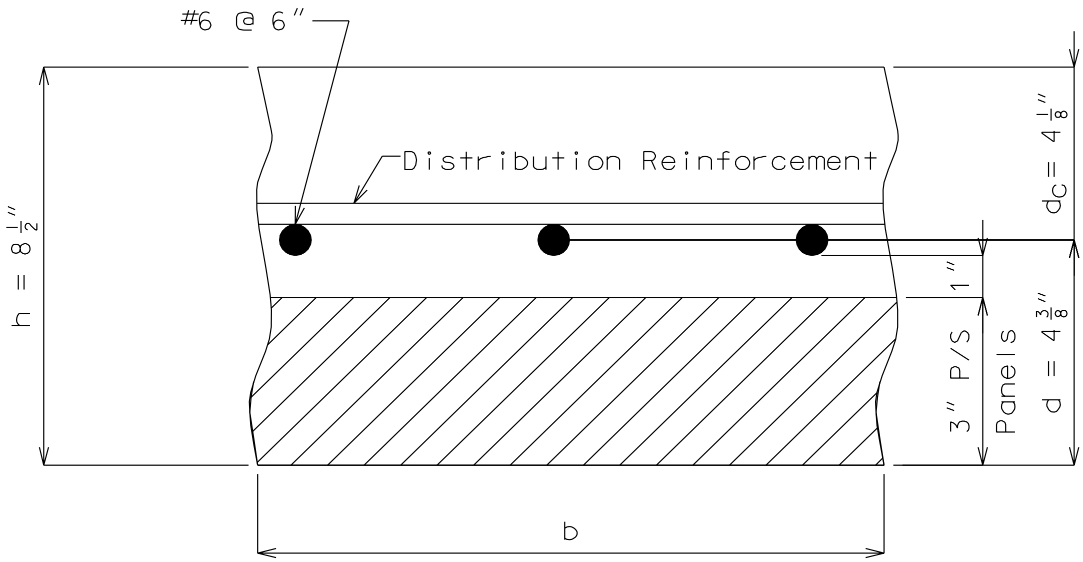


Figure 3.30.1.6 Example Slab Cross Section for Cracking Check

LRFD 9.7.1.3

Reinforcing Placement

Although LRFD Specifications allow slab primary reinforcing to be skewed with the bridge under certain cases, MoDOT Bridge practice is to place transverse reinforcing perpendicular to roadway.

Note:

Due to the depth of cover and location of primary reinforcement, the cracking check shown on the previous page does not appear to be accurate for Missouri's bridge decks shown above.

Negative Moment Steel over Intermediate Supports
Dimension negative moment steel over intermediate supports as shown in Figure 3.30.1.7.

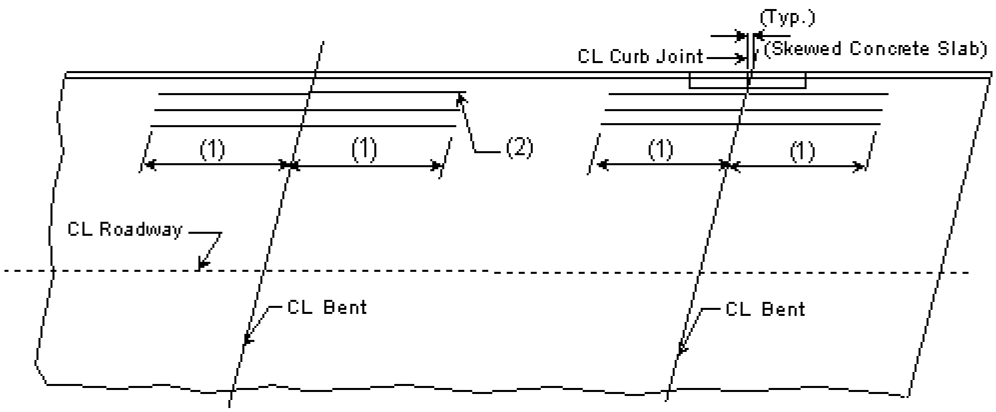
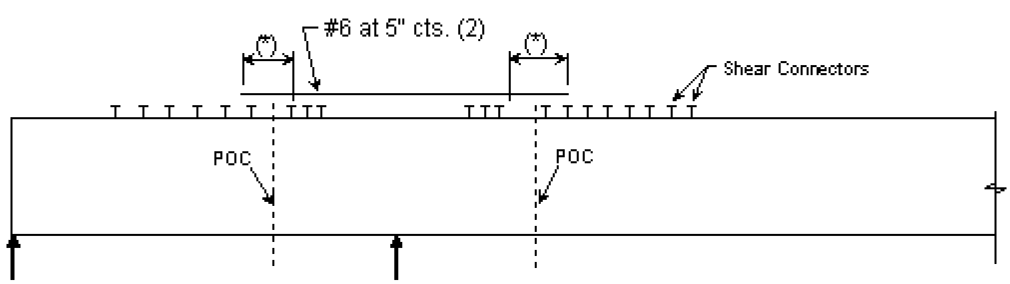


Figure 3.30.1.7 Prestressed Structures

(1) Bar length by design, see page 1.5-9.
(2) Reinforcement placed between longitudinal temperature reinforcing in top.
Bar size: #5 bars at 7-1/2" cts. (Min.)
#8 bars at 5" cts. (Max.)

Steel Structures:

(1) Extend into positive moment region beyond "Anchor" Stud shear connectors at least 40 x bar diameter x 1.5 (Epoxy Coated Factor)(*) as shown below.
(2) Use #6 bars at 5" cts. between longitudinal temperature reinforcing in top.



POC =DC Contra-Flexural Point

(*) 40 x bar diameter x 1.5 = 40 x 0.75" x 1.5 = 45” for #6 epoxy coated bars.

Locations of termination of reinforcement steel in the deck slab for Prestressed Structures shall be checked for the following criteria and adjusted as necessary:

LRFD 5.11.1.2.1

No more than 50 percent of the reinforcement shall be terminated at any section.

Adjacent bars shall not be terminated in the same section.

Flexural reinforcement shall be extended beyond the point at which it is no longer required to resist flexure for a distance not less than:

The effective depth of the member
15 times the nominal diameter of bar
1/20 of the clear span (centerline to centerline of pier)

Continuing reinforcement shall extend not less than the development length, ld, beyond the point where reinforcement is no longer required to resist flexure.

LRFD 5.11.1.2.3

At least one third of the total tension reinforcement provided for negative moment at a support shall have an embedment length beyond the point of inflection not less than:

The effective depth of the member
12 times the nominal diameter of bar
0.0625 times the clear span (centerline to centerline of pier)

1.6 Slab Overhang Section Design

Girder Layout

LRFD 4.6.2.2.1

In order to use distribution factors provided in LRFD Table 4.6.2.2.2 for girder design, the roadway overhang shall not exceed 3 ft.

Slab Thickness

LRFD 13.7.3.1.2

The slab overhang shall be 8 1/2" slab thickness.

LRFD A13.4

Design Cases

Four design cases shall be considered for each design condition.

Design Case 1 *EXTREME EVENT II* load combination with transverse and longitudinal collision force components

Design Case 2 *EXTREME EVENT II* load combination with vertical collision force components (Does not control slab for TL-4).

Design Case 3 *STRENGTH I* load combination

Design Case 4 *SERVICE I* load combination for cracking check

Design Conditions

Three design conditions may exist for slab overhang design.

Design Condition 1 – Continuous Slab & Continuous SBC

Design Condition 2 – Continuous Slab & Discontinuous SBC

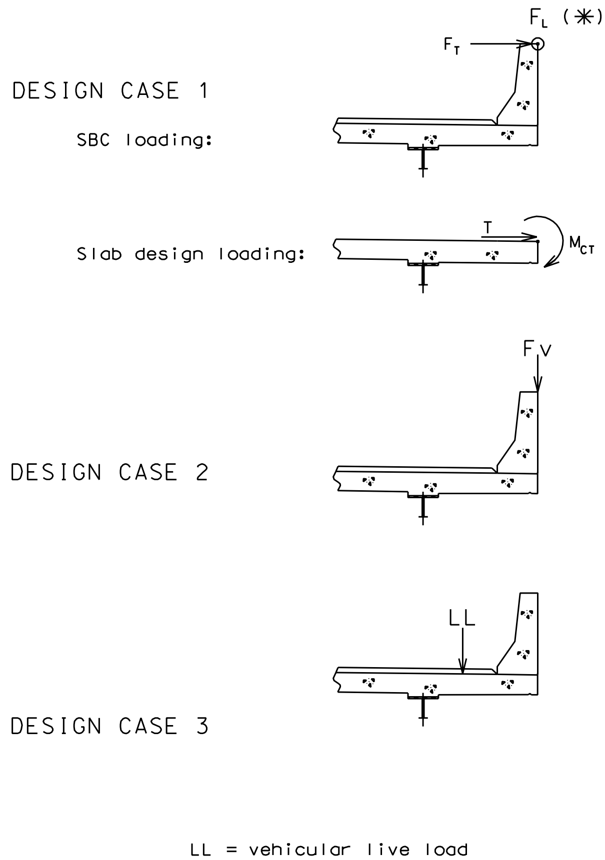
Design Condition 3 – Discontinuous Slab & Discontinuous SBC

Critical Sections

LRFD 4.6.2.1.6

The critical design section for slab overhang shall be at the following two locations:

- At roadway face of safety barrier curb
- At exterior girder:
  - For steel girders –the design negative moment should be taken at ¼ of the flange width from the centerline of the web.
  - For P/S-I girders -the design negative moment should be taken at 1/3 of the flange width, but not exceeding 15" from the centerline of the web



Note: Moment due to dead load components shall also be calculated
(✳) F_L is not considered in SBC or slab design for our standard barrier curb.

Figure 3.30.1.8 Slab Overhang Design Cases 1 to 3. Design Case 4 Not Shown.

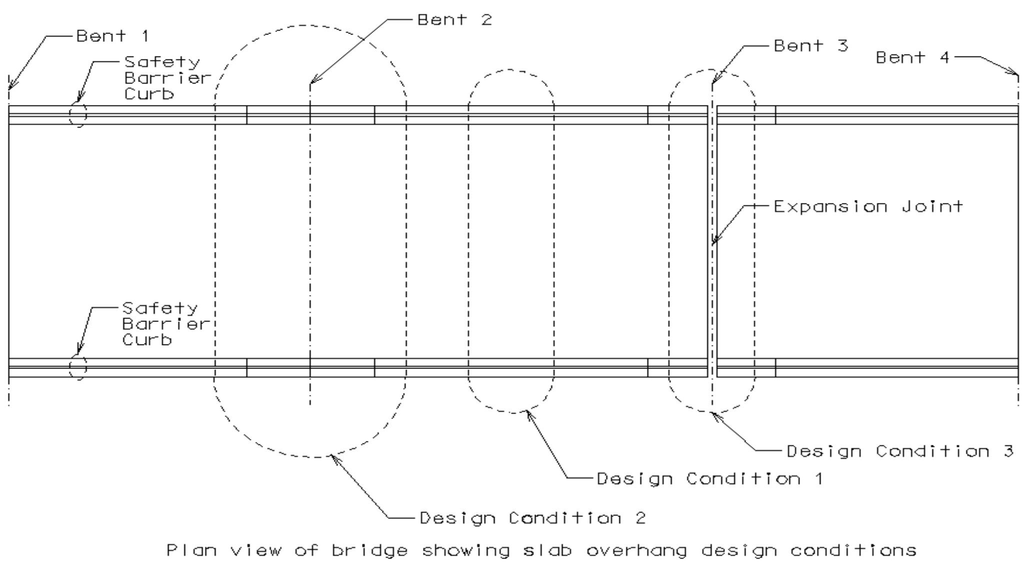


Figure 3.30.1.9 Plan View of Bridge Showing Slab Overhang Design Conditions

LRFD 4.6.2.1.3

Width of Equivalent Strip at Continuous Slab Section

The equivalent strip width for a continuous section of slab overhang shall be:

$E = 45 + 10x$

Where:
E = equivalent width (in)
x = distance from load to point of support (ft)

LRFD 4.6.2.1.4a & LRFD 4.6.2.1.4c

Width of Equivalent Strip at Discontinuous Slab Section

The effective strip width shall be taken as ½ of the equivalent strip width for a continuous slab section plus the distance between the transverse edge of slab and the edge beam (if any). This shall not be taken to be greater than equivalent strip width for continuous slab section.

Assumed Load Distribution

To determine the load effect at slab overhang critical sections, the slab shall be assumed as fixed at the exterior girder. This assumption is intended for slab design only, not the distribution of slab loads to girder.

For the purpose of determining the collision load effect at slab critical sections, the load may be assumed to fan out at 30 degrees on each side from the point of load.

Determining Top Reinforcing

The top (negative) reinforcing steel may be determined by assuming the section to be either singly- or doubly-reinforced, as needed. For slab overhang lengths equal to or less than 3'-10", the reinforcement shown in the standard slab details is adequate (see LRFD DG Sec. 3.30.1.7). For overhang lengths greater than 3'-10", further analysis is required for top transverse steel design.

Effect of Slab Drains

LRFD 9.4.2

The effect of slab drain openings in the slab overhang shall be considered. Their effect may be considered by ensuring the following:

$A_{s\text{-}provided} \geq A_{s\text{-}required}$

Where:

$A_{s\text{-}provided}$ = area of steel provided over the strip width including effect of drain openings

$A_{s\text{-}required}$ = area of steel required over strip width by calculation

Reinforcing Criteria

Reinforcing limits, cover, temperature steel, distribution steel, and placement shall be the same as for Slab Interior Section.

Special Considerations for SBC-Mounted Light Pole

AASHTO Std. Spec. for Structural Supports for Hwy Signs, Luminaires and Traffic Signals – 4th Ed. 2001

Standard details for mounting 30 ft. and 45 ft. Type B light poles on safety barrier bridge curb are provided in LRFD DG Sec. 3.32. At the barrier curb-to-slab interface, the force effect of wind on the light pole (*STRENGTH - III*) with 90 m.p.h. wind is less than that due to *EXTREME EVENT-II* (TL-4) on safety barrier bridge curb. Therefore, reinforcing designed for *EXTREME EVENT-II* (TL-4) load combination will be adequate.

GENERAL INFORMATION:

(A) Although P/S panel slabs are the standard, C.I.P. cross section are shown for information.

(B) This slab design includes an allowance for 35 psf future wearing surface.

(C) Slab design is based on ultimate strength design, f'_c = 4 ksi, and grade 60 reinforcing steel.

(D) Haunching diagrams shall be provided for only the P/S panel slab.

(E) Quantities for haunching are estimated by taking 4% of slab quantities for steel structures and 2% for prestressed structures.

(F) When the flange width exceeds the bottom longitudinal reinforcement spacing over the girder, reduce the bar spacing between the girders and increase the bar spacing over the girder to clear the flange edges.

(G) When the structure is on grade, determine lengths of the longitudinal reinforcement in the slab and safety barrier curb from the actual length.

(H) For slab design, the centerline of wheels is located 1 foot from face of curbs.

(I) The standard slabs were designed assuming 12” minimum flanges.

(J) When median barrier curb or safety barrier curb is permanently required on the structure, other than at the edge of slab, P/S panels will not be allowed in the bay underneath the curb. Check reinforcement in the C.I.P bay for collision and wheel loads on opposite faces of the curb and provide suitable anchorage of the reinforcing steel.

(K) The bridge roadway width, from gutter line to gutter line, shall be the same as the roadbed width (from outside edge of shoulder to outside edge of shoulder).

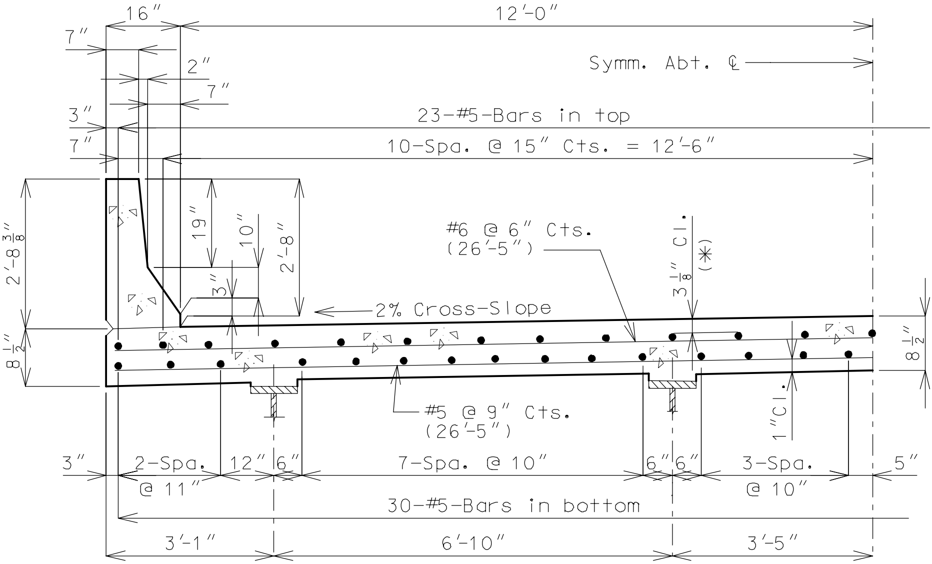
(L) The P/S panels must be used in at least two consecutive bays.

(M) Standard slabs do not include the effect of features not shown (i.e. sidewalk, fence, utilities, etc…) except for future wearing surface.

(O) Minimum concrete cover for slab top bars is 2 ¾” for #8 longitudinal bars.

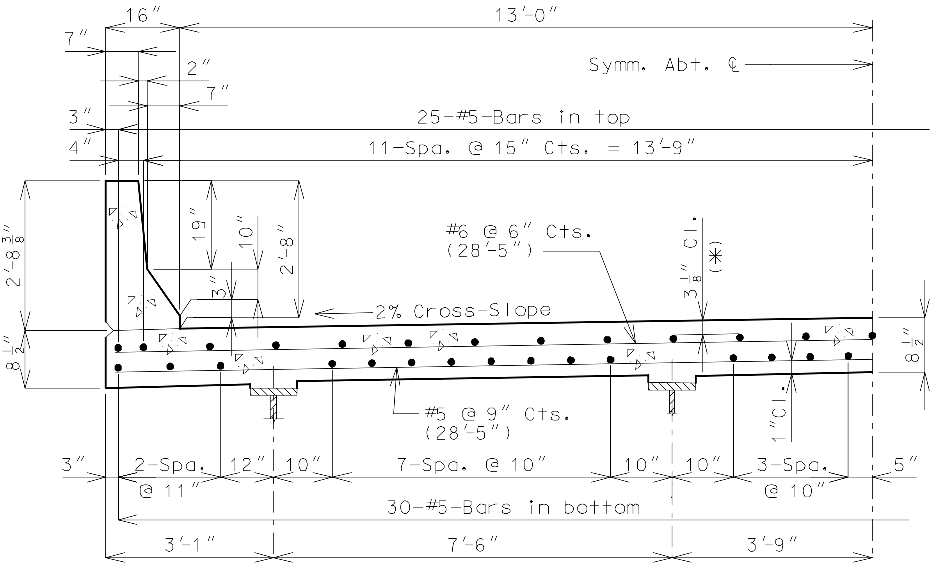
Note: Generally, when the deck is bid in Sq. Yd., curbs are bid in linear Ft., and when the deck is bid in Cu. Yd., curbs are bid in Cu. Yd.

Details of Concrete Slab on Girder (Cont.) **Slab on Girder**

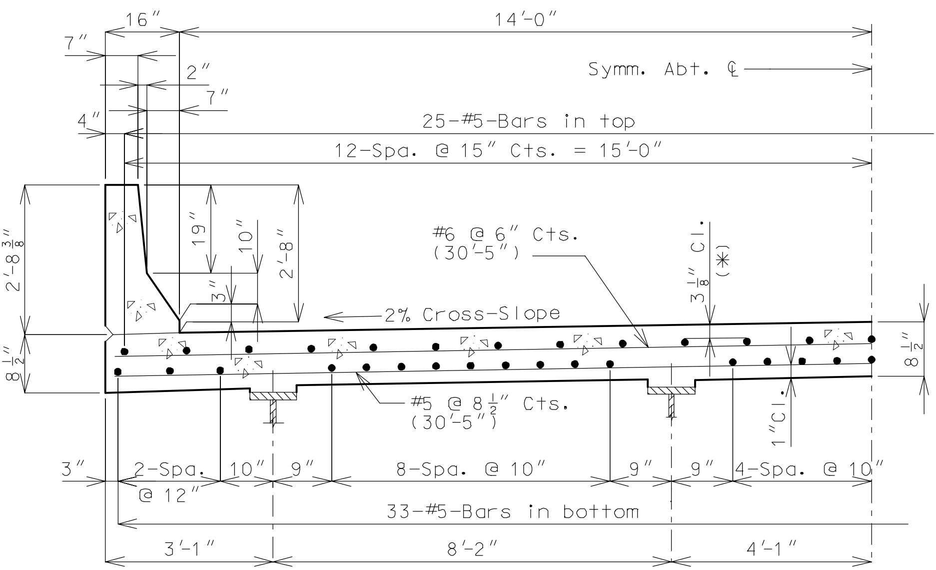


HL93 (24'-0" ROADWAY - 4 GIRDER)

Details of Concrete Slab on Girder (Cont.) **Slab on Girder**



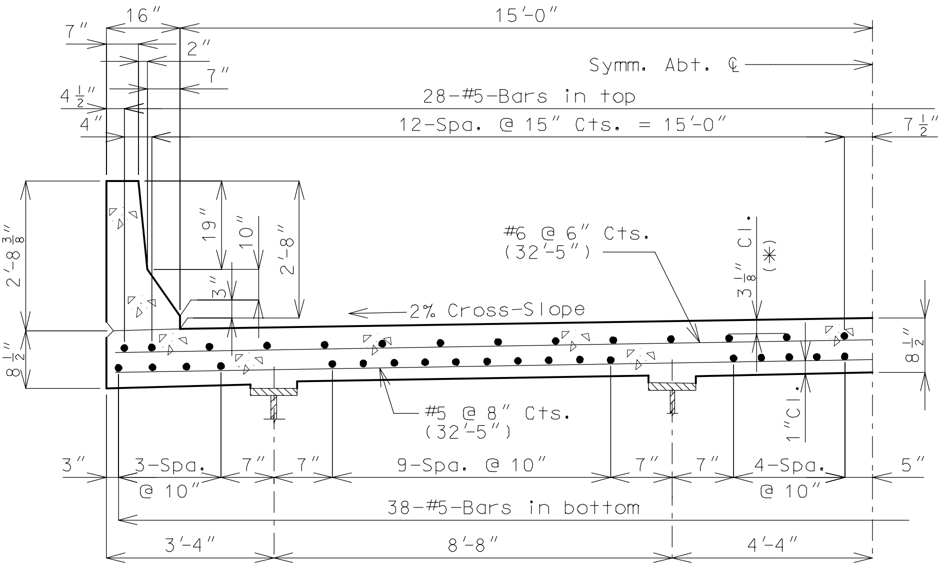
HL93 (26′-0″ ROADWAY - 4 GIRDER)



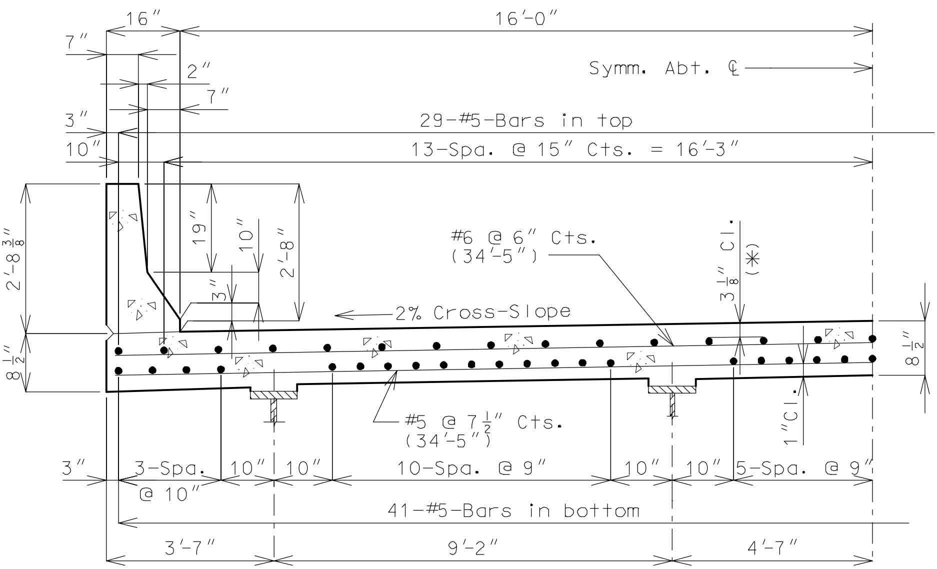
HL93 (28′-0″ ROADWAY - 4 GIRDER)

(✳) Cover will be less for other than #5 longitudinal bars.

Details of Concrete Slab on Girder (Cont.) **Slab on Girder**

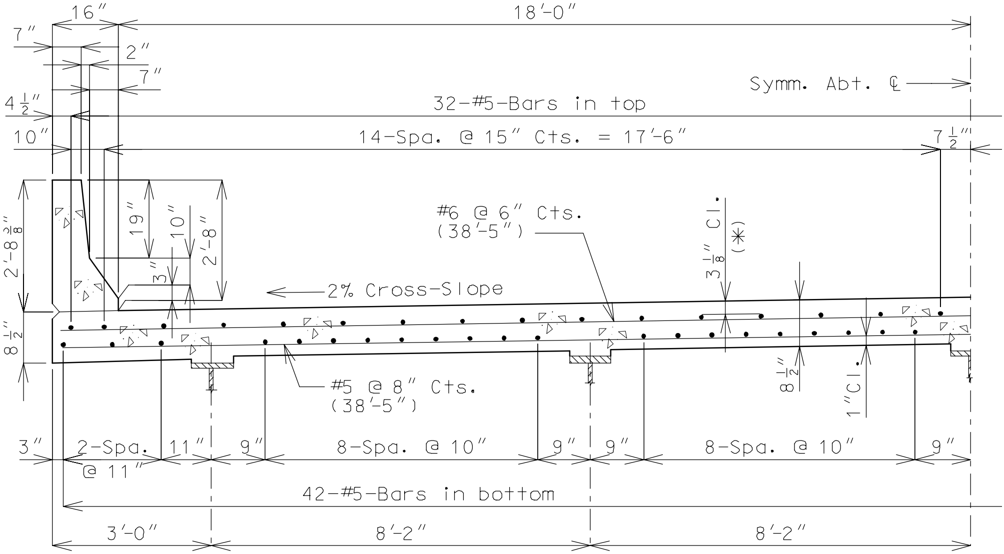


HL93 (30′-0″ ROADWAY - 4 GIRDER)

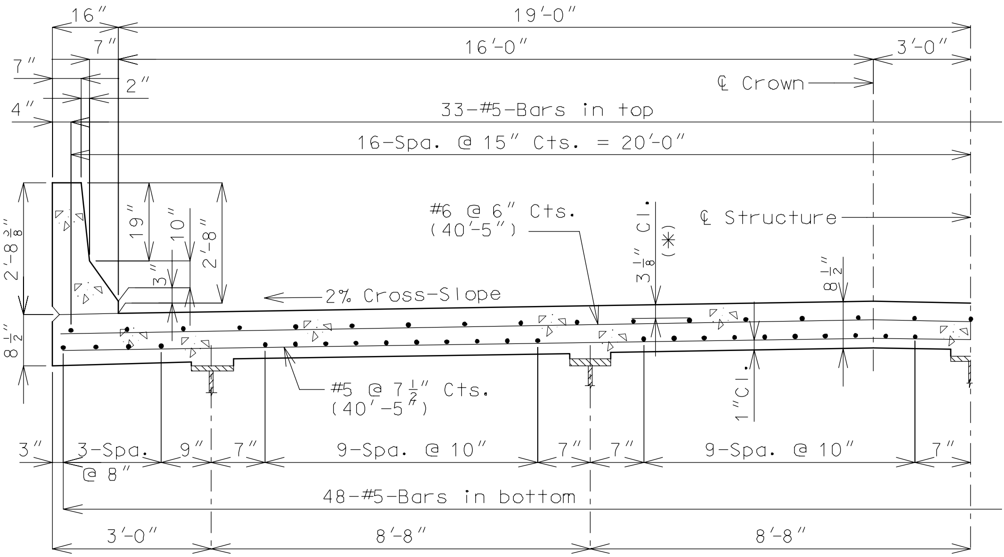


HL93 (32′-0″ ROADWAY - 4 GIRDER)

(✳) Cover will be less for other than #5 longitudinal bars.

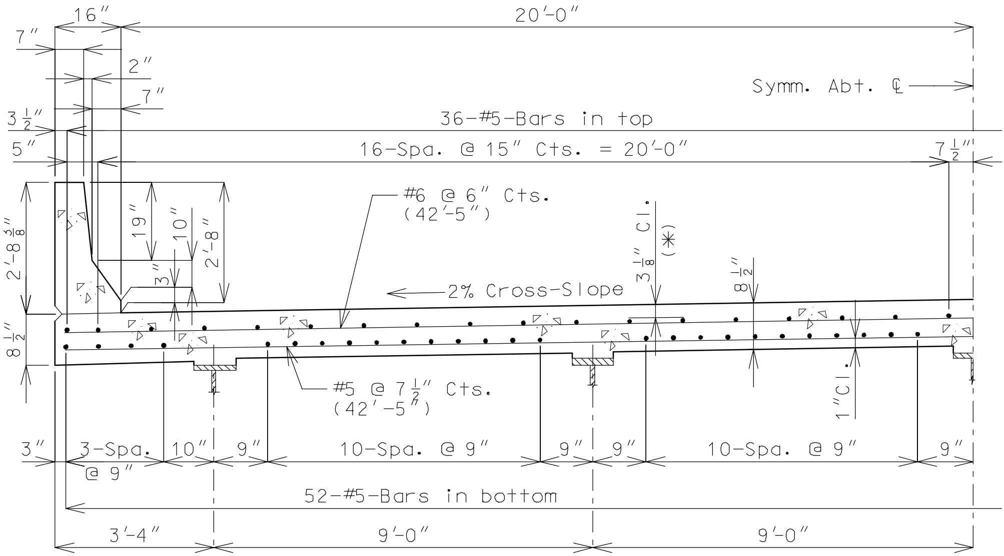


HL93 (36'-0" ROADWAY - 5 GIRDER)

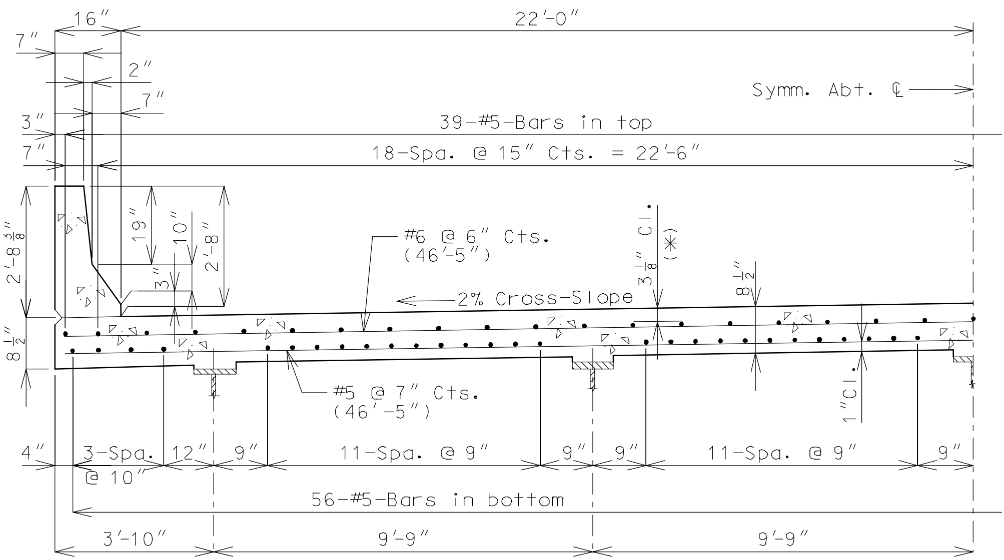


HL93 (38'-0" ROADWAY - 5 GIRDER) (UNSYMMETRICAL)

(✳) Cover will be less for other than #5 longitudinal bars.



HL93 (40'-0" ROADWAY - 5 GIRDER)



HL93 (44'-0" ROADWAY - 5 GIRDER)

(✳) Cover will be less for other than #5 longitudinal bars.

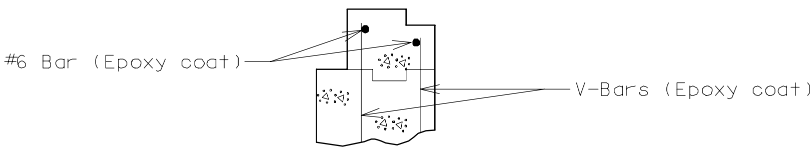
1.8 EPOXY COATED REINFORCEMENT

GENERAL

All reinforcement in the slab and above, and all reinforcement that extends into the slab, shall be epoxy coated; also, any wing reinforcement that extends into the safety barrier curb shall be epoxy coated.

NON-INTEGRAL END BENTS WITH EXPANSION DEVICES

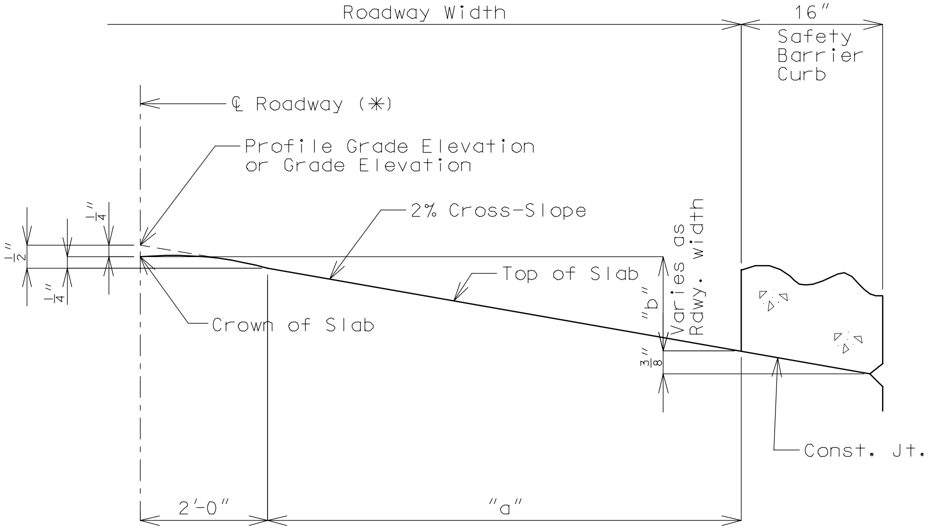
The #6 bars in the end bent backwall above the upper construction joint shall be epoxy coated. V-bars in the backwall shall also be epoxy coated.



BACKWALL

1.9 STANDARD 4'-0" PARABOLIC CROWN

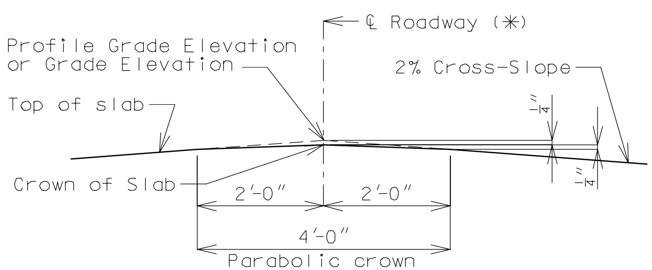
Use parabolic rounding for all bridges at the crown of the roadway except for the bridges with superelevated slabs. The profile grade will be at the intersection of the two cross-slopes if it is located at the crown of the roadway. (See Figure 3.30.1.9)



(✳) Omit when not applicable.

"b" (in inches) = "a" (in inches) x (2%) + 1/4"

Method of computing "b" (Slab on Tangent Alignment)



Standard Detail to Be Shown on Plans

FIGURE 3.30.1.10 PARABOLIC ROUNDING AT CROWN

1.10 PROFILE GRADE

See the Design Layout for location of the profile grade.

Generally, the profile grade is at the centerline of roadway for two-way traffic bridges as shown in Figure 3.30.1.10.

For one-way traffic bridges (as used in standard divided highways), the profile grade is at some other location away from the centerline of roadway.

Generally, the profile grade will be shown in the cross section through the superstructure on the slab sheet and in the plan view on the front sheet of the design plans.

Show stations and profile grade elevations for all bents in the plan view on the front sheet of the design plans. (See Figure 3.30.1.11)

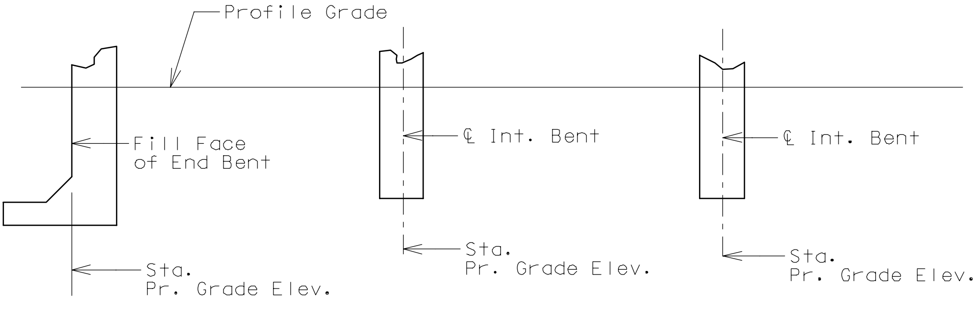


FIGURE 3.30.1.11 PART OF PLAN VIEW
(SHOWING STATIONS AND PROFILE GRADE ELEVATIONS)

VERTICAL CURVE DATA

Place the vertical curve data on the front sheet near the elevation view at the vertical curve P.I. station, or as near to the vertical curve P.I. station as practical. (See Figure 3.30.1.12)

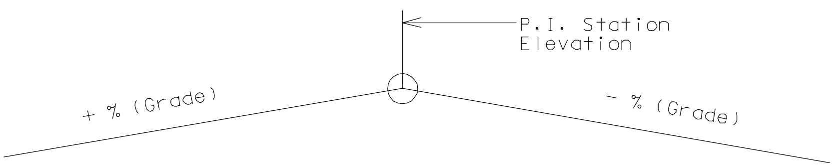


FIGURE 3.30.1.12 VERICAL CURVE INFORMATION

A crest vertical curve detail is shown. If the bridge is located on a sag vertical curve, then the detail for a sag vertical curve is to be used.

1.11 ELEVATIONS GENERAL

Slab elevations are used to determine haunching at the tenth points of steel and prestressed girder spans over seventy-five feet in length. Spans less than seventy-five feet in length use quarter points.

THEORETICAL BOTTOM OF SLAB ELEVATIONS AT ℄ OF GIRDER (PRIOR TO FORMING FOR SLAB)

Elevations and details for Theoretical Bottom of Slab Elevations at ℄ of girder (prior to forming for slab) shall be provided on all stringer or girder type structures.

Steel Girders

Elevations are determined by adding DL1 and DL2 deflections to finished bottom of slab elevations. DL1 deflections are reduced by the percent of dead load deflection due to the weight of structural steel. DL2 deflections are reduced by the percent of dead load deflection due to future wearing surface.

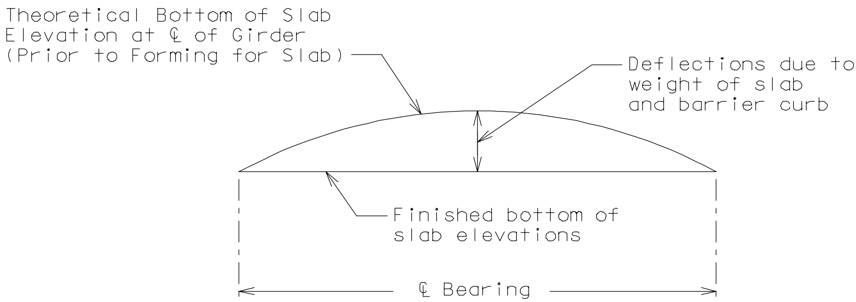
P/S I-Girders

Initial camber minus final camber is used to determine DL1 deflection.

(✱✱) Theoretical Bottom of Slab Elevations at ℄ of Girder (Prior to Forming for Slab)

	Span 1-2 (56'-5" ℄ Brg.- ℄ Brg.)					Span 2-3 (56'-5" ℄ Brg.- ℄ Brg.)					Span 3-4 (56'-5" ℄ Brg. - ℄ Brg.)				
	℄ brg.	.25	.50	.75	℄ brg.	℄ brg.	.25	.50	.75	℄ brg.	℄ brg.	.25	.50	.75	℄ brg.
Girders No. 1 and 9	970.65	970.75	970.81	970.83	970.81	970.81	970.82	970.79	970.72	970.61	970.60	970.52	970.41	970.25	970.05
Girders No. 2 and 8	970.81	970.91	970.98	970.99	970.96	970.96	970.98	970.95	970.88	970.76	970.75	970.68	970.57	970.41	970.20
Girders No. 3 and 7	970.96	971.06	971.12	971.14	971.11	971.11	971.13	971.10	971.03	970.91	970.90	970.83	970.72	970.56	970.36
Girders No. 4 and 6	971.11	971.21	971.28	971.29	971.26	971.26	971.28	971.25	971.18	971.07	971.05	971.98	970.87	970.71	970.51
Girders No. 5	971.25	971.35	971.41	971.43	971.40	971.40	971.42	971.39	971.32	971.20	971.19	971.12	971.01	970.85	970.64

(✱✱) Elevations are based on a constant slab thickness of 8 1/2" and include allowance for theoretical dead load deflections due to weight of Slab (including Prestressed Panel) and Barrier Curb.



TYPICAL SLAB ELEVATIONS DIAGRAM

Example:

972.0715	Finished top of Slab Elevation @ ℄ of girder
- 0.7083	Slab Thickness
971.3632	Finished Bottom of Slab Elevation @ ℄ of girder
+ 0.0478	Theoretical Dead Load Deflection due to weight of slab and barrier curb.
971.4110	Theoretical Bottom of Slab Elevation @ ℄ Girder (Prior to Forming for Slab)
971.41	(USE) Theoretical Bottom of Slab Elevation @ ℄ Girder (Prior to Forming for Slab)

TYPICAL FOR P/S I-GIRDER DESIGN AND DETAILS

AND

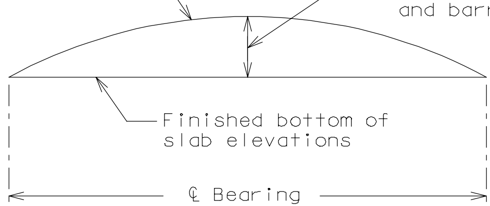
SIMPLE SPAN PLATE GIRDER AND WIDE FLANGE GIRDER DESIGN AND DETAILS

ELEVATIONS GENERAL (CONT.)

(**) Theoretical Bottom of Slab Elevations at ℄ of Girder (Prior to Forming for Slab)

	Span 1-2 (122'-0" ℄ Brg.-℄ Brg.)											Span 2-3 (122'-0" ℄ Brg.-℄ Brg.)									
	℄ Brg. Stiff.	.10	.20	.30	.40	.50	.60	.70	.80	.90	℄ Brg. Stiff.	.10	.20	.30	.40	.50	.60	.70	.80	.90	℄ Brg. Stiff.
Girders No. 1	829.65	829.80	829.92	830.02	830.10	830.14	830.16	830.16	830.15	830.14	830.14	830.15	830.16	830.18	830.19	830.18	830.14	830.08	829.98	829.86	829.73
Girders No. 2	829.82	829.97	830.10	830.20	830.27	830.31	830.33	830.32	830.31	830.29	830.28	830.29	830.31	830.33	830.34	830.33	830.30	830.23	830.13	830.00	829.86
Girders No. 3	829.97	830.12	830.25	830.35	830.42	830.45	830.47	830.46	830.44	830.42	830.42	830.42	830.44	830.46	830.47	830.45	830.42	830.35	830.25	830.12	829.97
Girders No. 4	829.86	830.00	830.13	830.23	830.30	830.33	830.34	830.33	830.31	830.29	830.28	830.29	830.31	830.32	830.33	830.31	830.27	830.20	830.10	829.97	829.82
Girders No. 5	829.73	829.86	829.98	830.08	830.14	830.18	830.19	830.18	830.16	830.15	830.14	830.14	830.15	830.16	830.16	830.14	830.10	830.02	829.92	829.80	829.65

(**) Elevations are based on a constant slab thickness of 8 1/2" and include allowance for theoretical dead load deflections due to weight of Slab (including Prestressed Panel) and Barrier Curb.



TYPICAL SLAB ELEVATIONS DIAGRAM

Example:

830.7504	Finished top of Slab Elevation @ ℄ of girder
− 0.7083	Slab Thickness
830.0421	Finished Bottom of Slab Elevation @ ℄ of girder
+ 0.1348	Theoretical Dead Load Deflection due to weight of slab and barrier curb.
830.1769	Theoretical Bottom of Slab Elevation @ ℄ Girder (Prior to Forming for Slab)
830.18	(USE) Theoretical Bottom of Slab Elevation @ ℄ Girder (Prior to Forming for Slab)

TYPICAL FOR PLATE GIRDER AND WIDE FLANGE DESIGN AND DETAILS

(Continuous Spans)

1.12 POURING AND FINISHING CONCRETE ROADWAY SLABS

Concrete pouring and finishing with/without rates are based on the following:

One pouring sequence must be provided that will permit a minimum pouring rate of 25 cubic yards per hour without retarder for steel structures and with retarder for prestressed structures. A minimum finishing rate of 20 linear feet per hour is also required. If these two requirements conflict, see the Structural Project Manager.

Continuous steel structures will normally require a case I pouring sequence with the basic sequence being a skip pour arrangement. Minimum yardage for the basic sequence shall not be less than 25 cubic yards per hour. Computation of minimum yardage for alternate pours is outlined below. If the rate for the alternate pours should be 25 yards or less, the skip pour basic sequence may be eliminated with the first alternate pour becoming the basic sequence.

Use of retarder is required for prestressed structures and a case II sequence ✳ is normally required. The minimum rate of pour will be determined by the 20 feet per hour minimum finishing rate but shall not be less than 25 cubic yards per hour. For span lengths over 80′ or special structures (segmental, etc.), see Structural Project Manager.

W = Slab width (out to out of curbs, or width being poured)(ft.)
T = 8 1/2″ (slab thickness)
V = Volume of concrete (cu. yds./hr.)
L (two span) = Length of longest alternate "A" pour (ft.)
L (more than two span) = Length of longest span (ft.)

✳ Case II sequence is used for all prestressed structures, except if slab area of one span is greater than 3,000 sq. ft., use case I.

Minimum rate of pour/hour for alternate pours (reduce V by 25% for P/C P/S Panels).

Without Retarder:

$V = (\frac{LWT}{27}).5$ Not less than 25 $yds.^3$/hr.

With Retarder:

$V = (\frac{LWT}{27}).3$ Not less than 25 $yds.^3$/hr.

Simple Span:

$V = (\frac{20' \times WT}{27})$ Not less than 25 $yds.^3$/hr.

Extra long span or extra wide bridges that indicate a basic rate greater than 25 $yds.^3$/hr. are to be checked with the Structural Project Manager.

The minimum rate of pour for solid slab or voided slabs is 20 linear feet of bridge per hour and not less than 25 cu. yds. per hour. Check pouring rates with Structural Project Manager if it is indicated necessary to exceed the basic minimum rate of 25 cu. yds. per hour.

The largest minimum rate of pour for alternate pours is 50 cu. yds. per hour in rural areas or 65 cu. yds. per hour in urban areas.

Notes See Section 4 H6.

SLAB POURING SEQUENCE TRANSVERSE CONSTRUCTION JOINTS

Slab Pouring Sequence - Bridges on Grade

All bridges on straight grades shall be poured up grade.

All bridges on vertical curves may be poured either up or down grade.

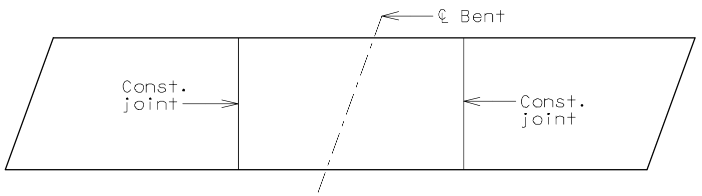
Transverse Construction Joint

On occasion, it will be necessary to off-set the transverse construction joint. For example, on bridges with large skews, wide roadways or short spans, the transverse construction joint could extend across the intermediate bent. Should this occur, the off-set or sawtooth construction joint shall be used.

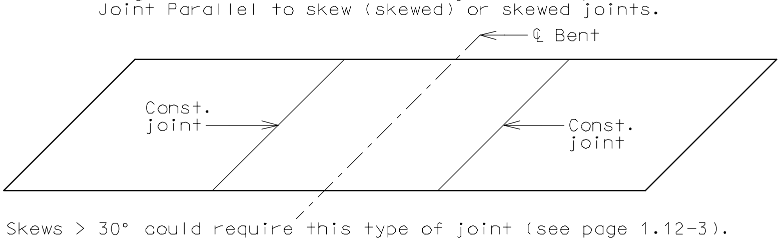
It is desirable to relocate const. joint within reason (6″±) should it cross additional negative slab reinforcement (see page 1.12-4). However, this shall not be considered critical.

Since the off-set construction joint creates construction problems, the designer shall avoid its use, if possible. Consult the Structural Project Manager for possible variations. See illustrations below for clarification.

Situation I: Square structures and small skew.
Joint normal to Bridge Centerline (Square) or Square Joint.

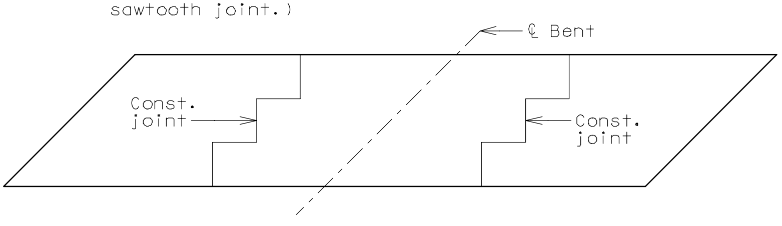


Situation II: Large skew (> 45°), wide roadways, short spans
Joint Parallel to skew (skewed) or skewed joints.



Note: Skews > 30° could require this type of joint (see page 1.12-3).

Situation III: Small skew when number of sawtooth is not excessive (off-set or sawtooth joint.)

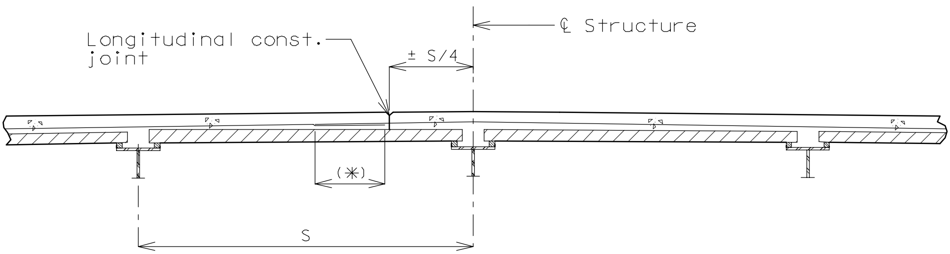


LONGITUDINAL CONSTRUCTION JOINTS

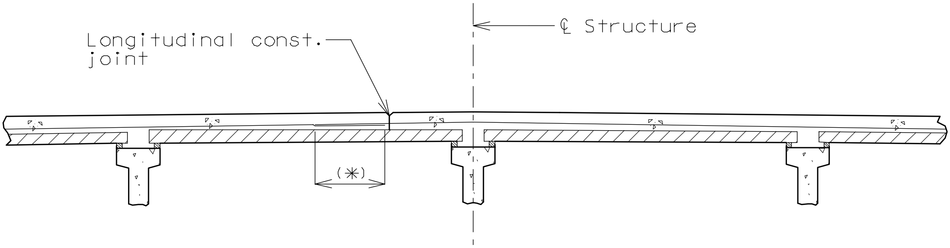
Wide Flange Beam, Plate Girder and Prestressed Girder

Normally, the maximum finishing width is 54'. Larger widths require longitudinal construction joints. Normally, the widest section of slab shall be poured first. During construction, the engineer may opt to eliminate this construction joint. Include note (H6.18) on roadways with longitudinal construction joints to address this option.

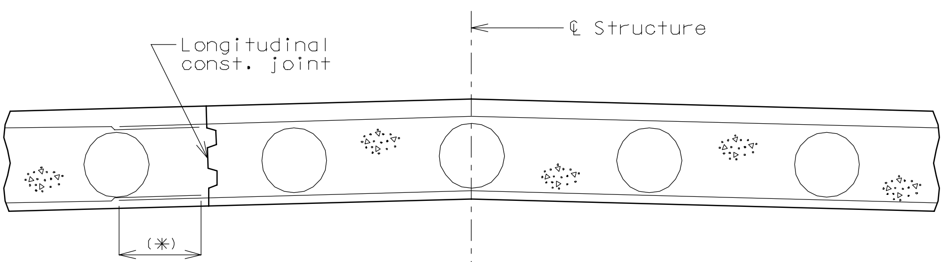
The finishing width shall be adjusted to finish the surface approximately parallel to the skew (i.e., skewed transverse construction joints) if the angle of skew exceeds 45° or if the angle of skew exceeds 30° and the ratio of placement width divided by span lengths equals or exceeds 0.8.



WIDE FLANGE BEAM OR PLATE GIRDER



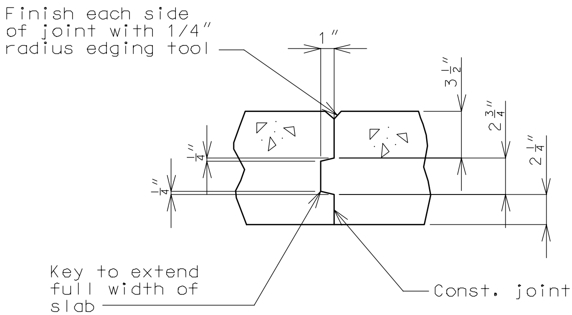
PRESTRESSED GIRDER



VOIDED SLAB

(✳) See Lap Splices of Tension Reinforcement - Section 2.4

POURING AND FINISHING CONCRETE ROADWAY SLABS



TYPICAL C.I.P. CONST. JOINT

Coefficients for Length of Pour

		Span Ratio n											
Spans	Coef.	1.0	1.1	1.2	1.25	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.0
2	a	.4	---	---	---	---	---	---	---	---	---	---	---
3	a	.4	.35	.30	.28	.25	.22	.20	.19	.18	.17	.16	.15
3	b	.15	.18	.21	.25	.30	.33	.35	.36	.37	.38	.39	.40
4 & 5	a	.4	.35	.30	.28	.25	.22	.20	.19	.18	.17	.16	.15
4 & 5	b	.15	.18	.21	.25	.30	.33	.35	.36	.37	.38	.39	.40
4 & 5	c	.15	.18	.21	.25	.30	.33	.35	.36	.37	.38	.39	.40

Use adjacent spans for ratio n.

Span lengths to be used are center to center of bearing.

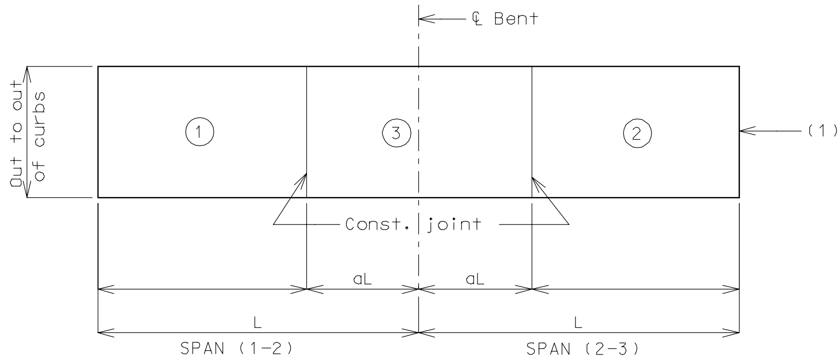
Modify the dimensions produced by the coefficients on wide roadways and large skews if they produce construction joints that are within 6" of the additional negative slab reinforcement (see LRFD DG Sec. 2.4).

Dimensions, except for terminal lengths of end spans, shall be to the nearest foot.

For 6 & 7 spans, use same coefficients for a, b, & c as for 4 & 5 spans.

SLAB POURING SEQUENCE - CASE I CONTINUOUS SPANS
I-BEAM, PLATE GIRDER AND PRESTRESSED CONCRETE: (2-SPAN)

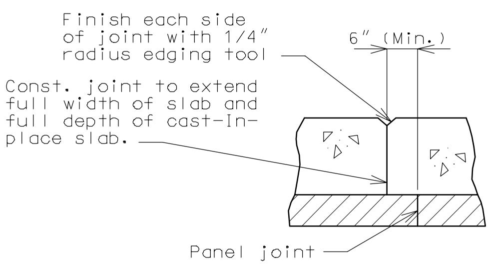
Note: When multi-series of spans are used - see Structural Project Manager.
Slab pours shown are to be reversed for bridges on a minus grade.
See Section 4-H6 for notes to be placed on the bridge plans.



(1) Fill face of end bent or appropriate exposed plates, angles, wide flanges, and joint filler required for expansion devices.
Note: For prestressed structures, "aL" may be made shorter than that indicated by the coefficients to balance pours.

	Sequence of Pours			Min. Rate of Pour Cu. Yds./Hr.	
	Direction			With Retarder	(✱) No Retarder
Basic Sequence	1	2	3	25	25
	Either Direction				
Alternate pours to the basic skip sequence are subject to the approval of the engineer in accordance with Sec 703.					
Alternate "A" Pours	1	3 + 2		(2)	(2)
	End to 3	1 to End			
Alternate "B" Pours	1 + 3 + 2			(2)	(2)
	End to End				

(2) See Bridge Manual Section 3.30, Page 1.12-1 for the minimum pour rates.

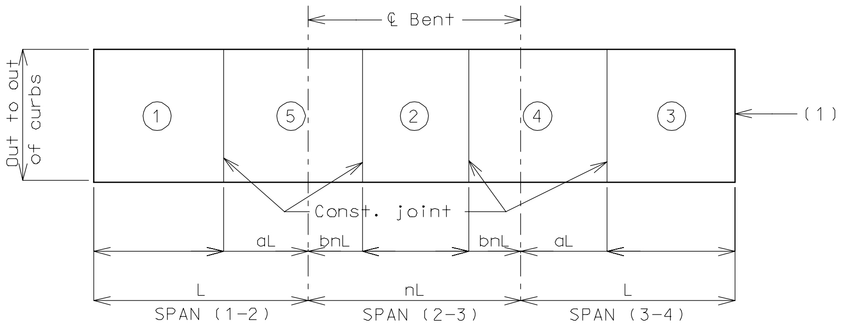


(✱) Not used for prestressed girders.

SECTION THRU CONSTRUCTION JOINT

SLAB POURING SEQUENCE - CASE I CONTINUOUS SPANS (CONT.)
I-BEAM, PLATE GIRDER AND PRESTRESSED CONCRETE: (3-SPAN)

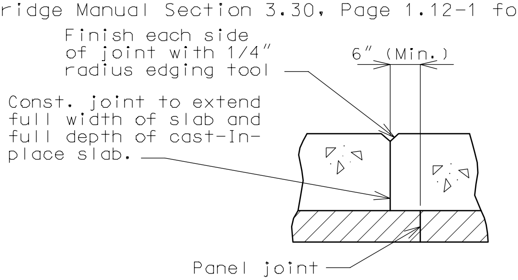
Note: When multi-series of spans are used - see Structural Project Manager.
Slab pours shown are to be reversed for bridges on a minus grade.
See Section 4-H6 for notes to be placed on the bridge plans.



(1) Fill face of end bent or appropriate exposed plates, angles, wide flanges, and joint filler required for expansion devices.
Note: For prestressed structures, "aL" and "bnL" may be made shorter than that indicated by the coefficients to balance pours.

<table>
<tr><td rowspan="2"></td><td colspan="6">Sequence of Pours</td><td colspan="2">Min. Rate of Pour Cu. Yds./Hr.</td></tr>
<tr><td colspan="6">Direction</td><td>With Retarder</td><td>(*) No Retarder</td></tr>
<tr><td rowspan="2">Basic Sequence</td><td>1</td><td>2</td><td>3</td><td>4</td><td colspan="2">5</td><td rowspan="2">25</td><td rowspan="2">25</td></tr>
<tr><td colspan="6">Either Direction</td></tr>
<tr><td colspan="9">Alternate pours to the basic skip sequence are subject to the approval of the engineer in accordance with Sec 703.</td></tr>
<tr><td rowspan="2">Alternate "A" Pours</td><td colspan="2">1</td><td colspan="2">5 + 2</td><td colspan="2">4 + 3</td><td rowspan="2">(2)</td><td rowspan="2">(2)</td></tr>
<tr><td colspan="2">End to 5</td><td colspan="2">1 to 4</td><td colspan="2">2 to End</td></tr>
<tr><td rowspan="2">Alternate "B" Pours</td><td colspan="3">1 + 5 + 2</td><td colspan="3">4 + 3</td><td rowspan="2">(2)</td><td rowspan="2">(2)</td></tr>
<tr><td colspan="3">End to 4</td><td colspan="3">2 to End</td></tr>
<tr><td rowspan="2">Alternate "C" Pours</td><td colspan="6">1 + 5 + 2 + 4 + 3</td><td rowspan="2">(2)</td><td rowspan="2">(2)</td></tr>
<tr><td colspan="6">End to End</td></tr>
</table>

(2) See Bridge Manual Section 3.30, Page 1.12-1 for the minimum pour rates.

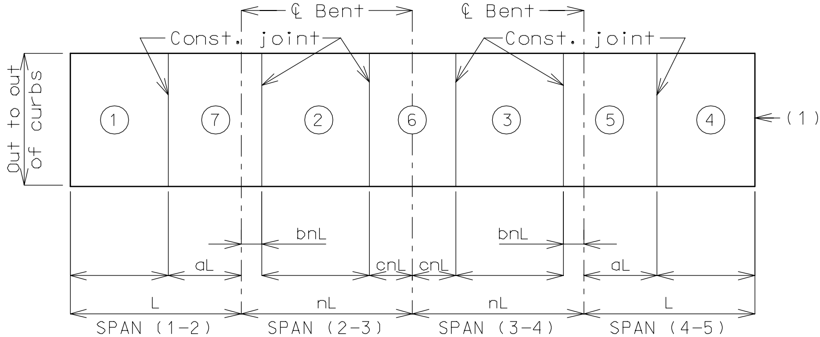


(*) Not used for prestressed girders.

SECTION THRU CONSTRUCTION JOINT

SLAB POURING SEQUENCE - CASE I CONTINUOUS SPANS (CONT.)
I-BEAM, PLATE GIRDER AND PRESTRESSED CONCRETE: (4-SPAN)

Note: When multi-series of spans are used - see Structural Project Manager. Slab pours shown are to be reversed for bridges on a minus grade. See Section 4-H6 for notes to be placed on the bridge plans.

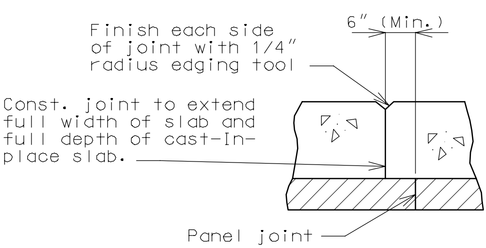


(1) Fill face of end bent or appropriate exposed plates, angles, wide flanges, and joint filler required for expansion devices.
Note: For prestressed structures, "aL" and "bnL" may be made shorter than that indicated by the coefficients to balance pours.

<table>
<tr><td rowspan="2"></td><td colspan="84">Sequence of Pours</td><td colspan="2">Min. Rate of Pour Cu. Yds./Hr.</td></tr>
<tr><td colspan="84">Direction</td><td>With Retarder</td><td>(*) No Retarder</td></tr>
<tr><td rowspan="2">Basic Sequence</td><td colspan="12">1</td><td colspan="12">2</td><td colspan="12">3</td><td colspan="12">4</td><td colspan="12">5</td><td colspan="12">6</td><td colspan="12">7</td><td rowspan="2">25</td><td rowspan="2">25</td></tr>
<tr><td colspan="84">Either Direction</td></tr>
<tr><td colspan="87">Alternate pours to the basic skip sequence are subject to the approval of the engineer in accordance with Sec 703.</td></tr>
<tr><td rowspan="2">Alternate "A" Pours</td><td colspan="21">1</td><td colspan="21">7 + 2</td><td colspan="21">6 + 3</td><td colspan="21">5 + 4</td><td rowspan="2">(2)</td><td rowspan="2">(2)</td></tr>
<tr><td colspan="21">End to 7</td><td colspan="21">1 to 6</td><td colspan="21">2 to 5</td><td colspan="21">3 to End</td></tr>
<tr><td rowspan="2">Alternate "B" Pours</td><td colspan="28">1 + 7 + 2</td><td colspan="28">6 + 3</td><td colspan="28">5 + 4</td><td rowspan="2">(2)</td><td rowspan="2">(2)</td></tr>
<tr><td colspan="28">End to 6</td><td colspan="28">2 to 5</td><td colspan="28">3 to End</td></tr>
<tr><td rowspan="2">Alternate "C" Pours</td><td colspan="42">1 + 7 + 2</td><td colspan="42">6 + 3 + 5 + 4</td><td rowspan="2">(2)</td><td rowspan="2">(2)</td></tr>
<tr><td colspan="42">End to 6</td><td colspan="42">2 to End</td></tr>
<tr><td rowspan="2">Alternate "D" Pours</td><td colspan="84">1 + 7 + 2 + 6 + 3 + 5 + 4</td><td rowspan="2">(2)</td><td rowspan="2">(2)</td></tr>
<tr><td colspan="84">End to End</td></tr>
</table>

(2) See Bridge Manual Section 3.30, Page 1.12-1 for the minimum pour rates.

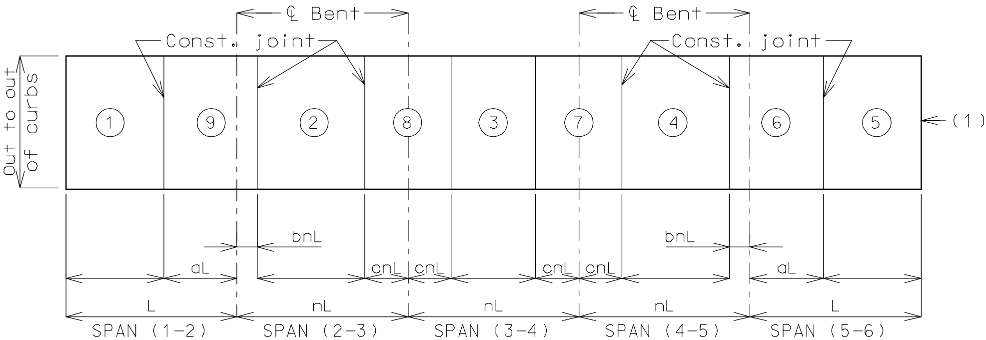
(*) Not used for prestressed girders.



SECTION THRU CONSTRUCTION JOINT

SLAB POURING SEQUENCE - CASE I CONTINUOUS SPANS (CONT.)
I-BEAM, PLATE GIRDER AND PRESTRESSED CONCRETE: (5-SPAN)

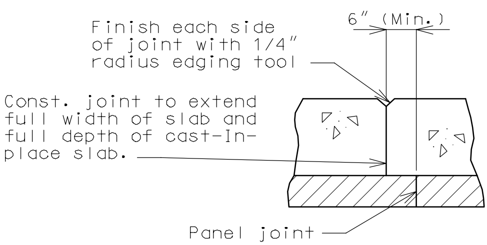
Note: When multi-series of spans are used - see Structural Project Manager. Slab pours shown are to be reversed for bridges on a minus grade. See Section 4-H6 for notes to be placed on the bridge plans.



(1) Fill face of end bent or appropriate exposed plates, angles, wide flanges, and joint filler required for expansion devices.
Note: For prestressed structures, "aL" and "bnL" may be made shorter than that indicated by the coefficients to balance pours.

<table>
<tr><td rowspan="2"></td><td colspan="9">Sequence of Pours</td><td colspan="2">Min. Rate of Pour Cu. Yds./Hr.</td></tr>
<tr><td colspan="9">Direction</td><td>With Retarder</td><td>(*) No Retarder</td></tr>
<tr><td rowspan="2">Basic Sequence</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td rowspan="2">25</td><td rowspan="2">25</td></tr>
<tr><td colspan="9">Either Direction</td></tr>
<tr><td colspan="12">Alternate pours to the basic skip sequence are subject to the approval of the engineer in accordance with Sec 703.</td></tr>
<tr><td rowspan="2">Alternate "A" Pours</td><td colspan="2">1</td><td colspan="2">9 + 2</td><td colspan="2">8 + 3</td><td colspan="2">7 + 4</td><td>6 + 5</td><td rowspan="2">(2)</td><td rowspan="2">(2)</td></tr>
<tr><td colspan="2">End to 9</td><td colspan="2">1 to 8</td><td colspan="2">2 to 7</td><td colspan="2">3 to 6</td><td>4 to End</td></tr>
<tr><td rowspan="2">Alternate "B" Pours</td><td colspan="3">1 + 9 + 2</td><td colspan="3">8 + 3</td><td colspan="3">7 + 4 + 6 + 5</td><td rowspan="2">(2)</td><td rowspan="2">(2)</td></tr>
<tr><td colspan="3">End to 8</td><td colspan="3">2 to 7</td><td colspan="3">3 to End</td></tr>
<tr><td rowspan="2">Alternate "C" Pours</td><td colspan="5">1 + 9 + 2 + 8 + 3</td><td colspan="4">7 + 4 + 6 + 5</td><td rowspan="2">(2)</td><td rowspan="2">(2)</td></tr>
<tr><td colspan="5">End to 7</td><td colspan="4">3 to End</td></tr>
<tr><td rowspan="2">Alternate "D" Pours</td><td colspan="9">1 + 9 + 2 + 8 + 3 + 7 + 4 + 6 + 5</td><td rowspan="2">(2)</td><td rowspan="2">(2)</td></tr>
<tr><td colspan="9">End to End</td></tr>
</table>

(2) See Bridge Manual Section 3.30, Page 1.12-1 for the minimum pour rates.

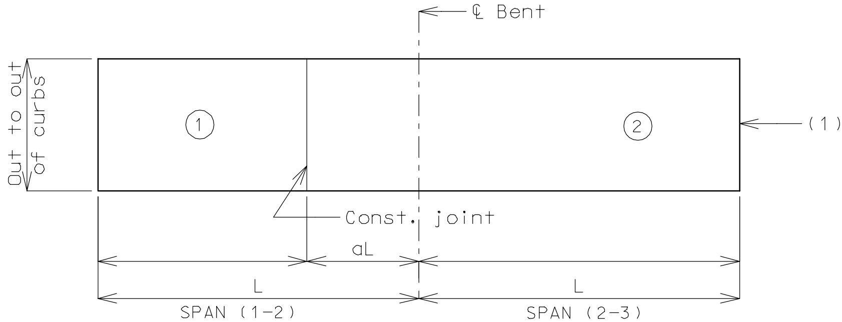


SECTION THRU CONSTRUCTION JOINT

(*) Not used for prestressed girders.

SLAB POURING SEQUENCE - CASE II CONTINUOUS SPANS
PRESTRESSED CONCRETE: (2-SPAN)

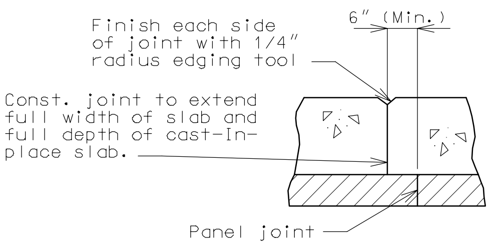
Note: Pouring sequence used on prestressed concrete with a basic rate of 25 cu. yds./hr. When multi-series of spans are used - see Structural Project Manager. Slab pours shown are to be reversed for bridges on a minus grade. See Section 4-H6 for notes to be placed on the bridge plans.



(1) Fill face of end bent or appropriate exposed plates, angles, wide flanges, and joint filler required for expansion devices.

	Sequence of Pours		Min. Rate of Pour Cu. Yds./Hr.
	Direction		With Retarder
Basic Sequence	1	2	25
	End to 2	1 to End	
Alternate pours to the basic sequence are subject to the approval of the engineer in accordance with Sec 703.			
Alternate "A" Pours	1 + 2		(2)
	End to End		

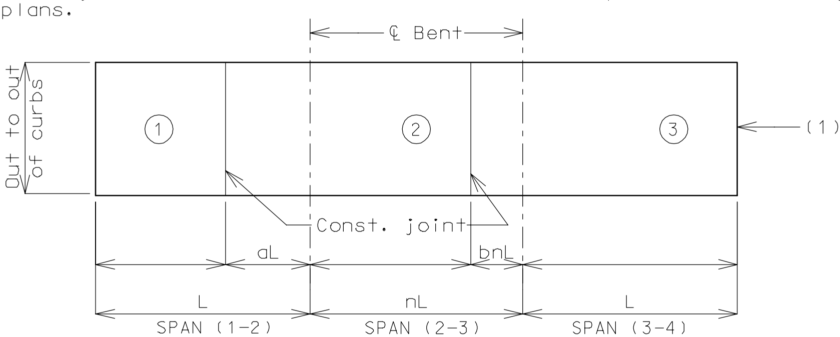
(2) See Bridge Manual Section 3.30, Page 1.12-1 for the minimum pour rates.



SECTION THRU CONSTRUCTION JOINT

SLAB POURING SEQUENCE - CASE II CONTINUOUS SPANS (CONT.)
PRESTRESSED CONCRETE: (3-SPAN)

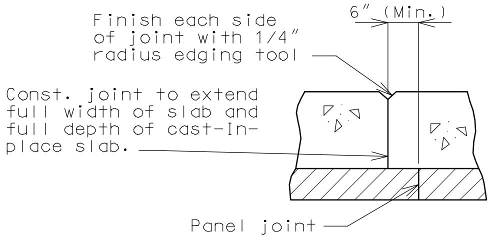
Note: Pouring sequence used on prestressed concrete with a basic rate of 25 cu. yds./hr. When multi-series of spans are used - see Structural Project Manager. Slab pours shown are to be reversed for bridges on a minus grade. See Section 4-H6 for notes to be placed on the bridge plans.



(1) Fill face of end bent or appropriate exposed plates, angles, wide flanges, and joint filler required for expansion devices.
Note: For prestressed structures, "aL" and "bnL" may be made shorter than that indicated by the coefficients to balance pours.

	Sequence of Pours			Min. Rate of Pour Cu. Yds./Hr.
	Direction			With Retarder
Basic Sequence	1	2	3	25
	End to 2	1 to 3	2 to End	
Alternate pours to the basic sequence are subject to the approval of the engineer in accordance with Sec 703.				
Alternate "A" Pours	1 + 2		3	(2)
	End to 3		2 to End	
Alternate "B" Pours	1 + 2 + 3			(2)
	End to End			

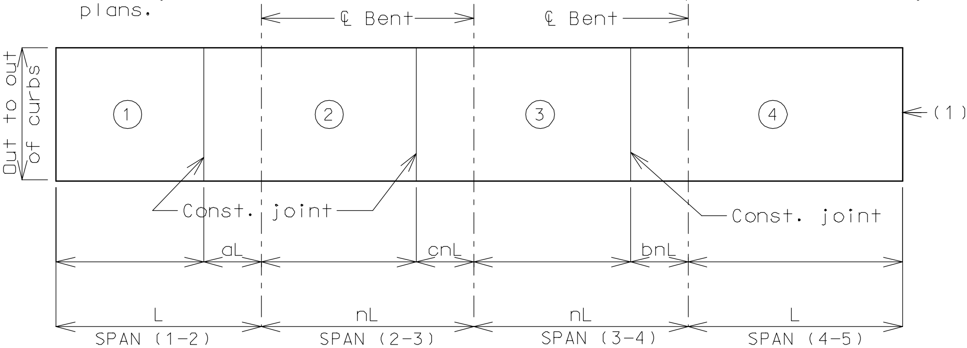
(2) See page 1.12-1 for the minimum pour rates.



SECTION THRU CONSTRUCTION JOINT

SLAB POURING SEQUENCE - CASE II CONTINUOUS SPANS (CONT.)
PRESTRESSED CONCRETE: (4-SPAN)

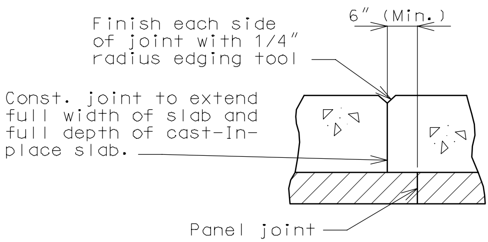
Note: Pouring sequence used on prestressed concrete with a basic rate of 25 cu. yds./hr. When multi-series of spans are used - see Structural Project Manager. Slab pours shown are to be reversed for bridges on a minus grade. See Section 4-H6 for notes to be placed on the bridge plans.



(1) Fill face of end bent or appropriate exposed plates, angles, wide flanges, and joint filler required for expansion devices.
Note: For prestressed structures, "aL" and "bnL" may be made shorter than that indicated by the coefficients to balance pours.

	Sequence of Pours				Min. Rate of Pour Cu. Yds./Hr.
	Direction				With Retarder
Basic Sequence	1 End to 2	2 1 to 3	3 2 to 4	4 3 to End	25
Alternate pours to the basic sequence are subject to the approval of the engineer in accordance with Sec 703.					
Alternate "A" Pours	1 + 2 End to 3	3 2 to 4	4 3 to End		(2)
Alternate "B" Pours	1 + 2 End to 3	3 + 4 2 to End			(2)
Alternate "C" Pours	1 + 2 + 3 + 4 End to End				(2)

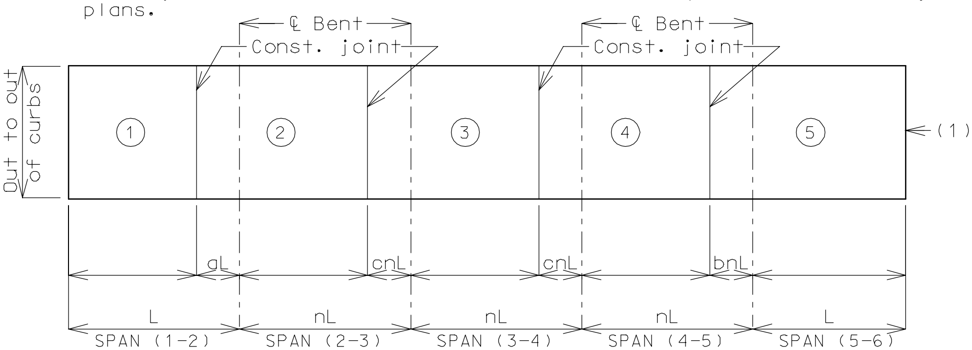
(2) See page 1.12-1 for the minimum pour rates.



SECTION THRU CONSTRUCTION JOINT

SLAB POURING SEQUENCE - CASE II CONTINUOUS SPANS PRESTRESSED CONCRETE: (5-SPAN)

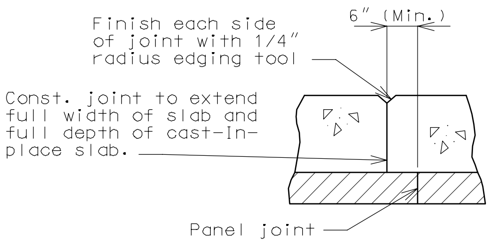
Note: Pouring sequence used on prestressed concrete with a basic rate of 25 cu. yds./hr. When multi-series of spans are used - see Structural Project Manager. Slab pours shown are to be reversed for bridges on a minus grade. See Section 4-H6 for notes to be placed on the bridge plans.



(1) Fill face of end bent or appropriate exposed plates, angles, wide flanges, and joint filler required for expansion devices.
Note: For prestressed structures, "aL" and "bnL" may be made shorter than that indicated by the coefficients to balance pours.

	Sequence of Pours					Min. rate of pour Cu. Yds./Hr.
	Direction					With Retarder
Basic Sequence	1 End to 2	2 1 to 3	3 2 to 4	4 3 to 5	5 4 to End	25
Alternate pours to the basic sequence are subject to the approval of the engineer in accordance with Sec 703.						
Alternate "A" Pours	1 + 2 End to 3	3 2 to 4	4 + 5 3 to End			(2)
Alternate "B" Pours	1 + 2 + 3 End to 4	4 + 5 3 to End				(2)
Alternate "C" Pours	1 + 2 + 3 + 4 + 5 End to End					(2)

(2) See page 1.12-1 for the minimum pour rates.



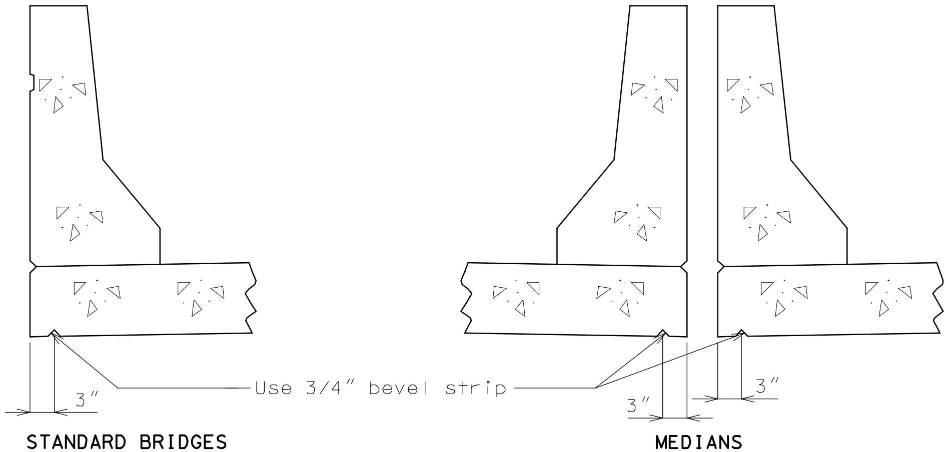
SECTION THRU CONSTRUCTION JOINT

1.13 CONCRETE MEDIANS

See LRFD DG Sec. 3.32

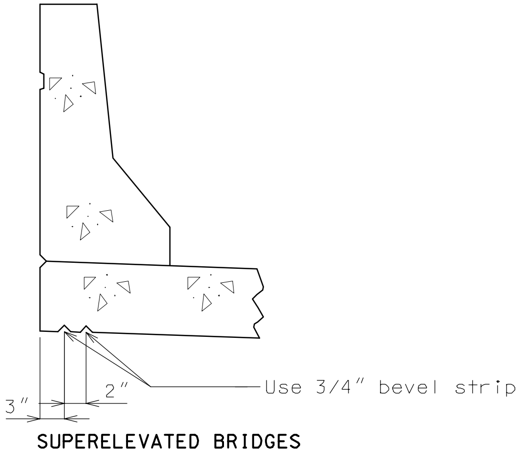
1.14 DRIP BEVEL: SAFETY BARRIER BRIDGE CURBS

Single Drip Bevel

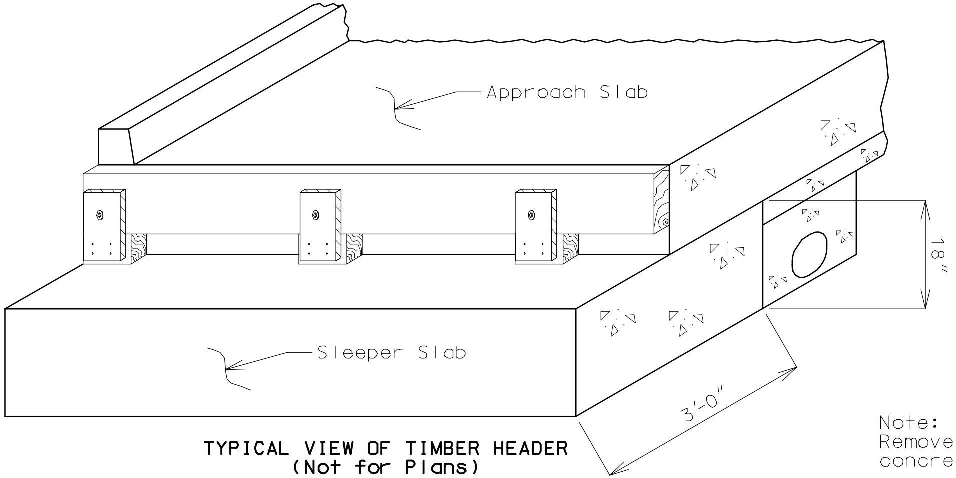


Use a single drip bevel on all standard bridges, the low side of superelevated bridges, the high side of superelevated continuous concrete slab bridges, and at medians.

Double Drip Bevel

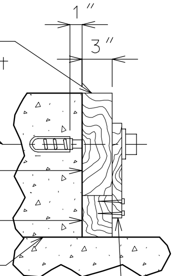


Use a double drip bevel on the high side of all superelevated bridges (except continuous concrete slab bridges), and box girder bridges.

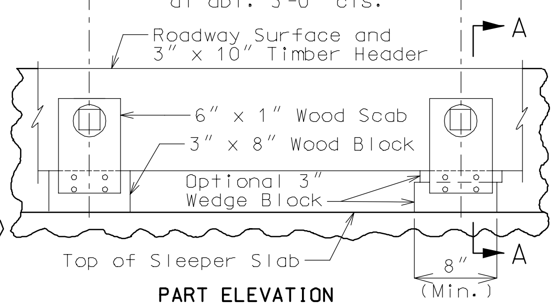


TYPICAL VIEW OF TIMBER HEADER
(Not for Plans)

Note:
Remove timber header when concrete pavement is placed.



SECTION A-A



PART ELEVATION

DETAILS OF TIMBER HEADER

Note: Cost of timber headers complete in place shall be included in price bid for Bridge Approach Slab (Bridge).

3.30.2 Stay in Place Deck Formwork

2.1 Prestressed Panels

Design Criteria

Precast prestressed concrete panels shall be 3” thick with 5.5” cast-in-place concrete slab. Panel concrete strength shall be f'_c = 6.0 ksi and f'_{ci} = 4.0 ksi. Cast-in-place slab shall be of strength f'_c = 4.0 ksi. The panels are considered as beams for analysis and design.

LRFD 5.4.4.1
LRFD 5.4.4.2

Prestressing steel shall be AASHTO M 203 (ASTM A 416) – Uncoated Seven-Wire, Low-Relaxation Strands. The strands will be grade 270 ksi, have a nominal diameter of 3/8”, area of 0.085 in.^{2}, and be spaced at 4.5” in the panels.

f_{pu} = ultimate strength of strands = 270 ksi
f_y = yield strength of strands = $0.9f_{pu}$ = 243 ksi
E_p = modulus of elasticity of strands = 28,500 ksi

Panels shall be set on joint filler in accordance with Sec 1057.6 of Missouri Standard Specifications or polystyrene bedding material. Filler thickness shall be a minimum of 1” and a maximum of 2”. Standard filler width is 1.5” except at splice plates where 3/4” minimum is allowed to clear splice bolts. Joint filler thickness may be reduced to a minimum of 3/4” over splice plates on steel structures. The joint filler thickness may also be varied within these limits to offset girder camber or at the contractor’s option a uniform 1” (min.) thickness may be used throughout. The same thickness shall be used under any one edge of any panel and the maximum change in thickness between adjacent panel shall be 1/4”.

As per the above criteria, the following shall control the panel width, measured parallel to the prestressing strands:

- Maximum Panel Width = 9’-6”
- Maximum Girder Spacing = 10’-0”
- Minimum Panel Width = 4’-0”

Precast prestressed panels must be used in at least two consecutive bays.

When a median barrier curb is permanently required on the structure, precast prestressed panels will not be allowed in the bay underneath the curb.

Note: Units of stress are in ksi.

Load Definitions

Non-Composite Loading – This is the loading that occurs before the cast-in-place concrete slab hardens and acts compositely with the prestressed panels. The contributions to the Non-Composite Loading are as follows:
- Precast Prestressed Panel, *DC*
- Cast-In-Place Slab, *DC*
- Additional Slab Weight due to excess haunch, *DC*
- Construction Load of 50 lb/ft^2

Composite Loading – This is the loading that occurs after the cast-in-place concrete slab hardens and acts compositely with the prestressed panels. The contributions to Composite Loading are as follows:
- Future Wearing Surface, *DW*
- Safety Barrier Curb, *DC*
- Design Live Load, *LL*

Prestress Losses

Refined estimates of time-dependent losses are used, based on LRFD 5.9.5.4, as opposed to approximate lump sum estimate of losses in LRFD 5.9.5.3.

The prestress losses shall be calculated to investigate concrete stresses at two different stages.
1) Temporary stresses immediately after transfer:
2) Final stresses

The prestress loss for temporary stress checks is:
$\Delta f_{pI} = \Delta f_{pES} + \Delta f_{pSR} + \Delta f_{pCR} + \Delta f_{pR1}$

The prestress loss for final stress checks
LRFD 5.9.5.1 $\Delta f_{pT} = \Delta f_{pI} + \Delta f_{pSD} + \Delta f_{pCD} + \Delta f_{pR2} - \Delta f_{pSS}$

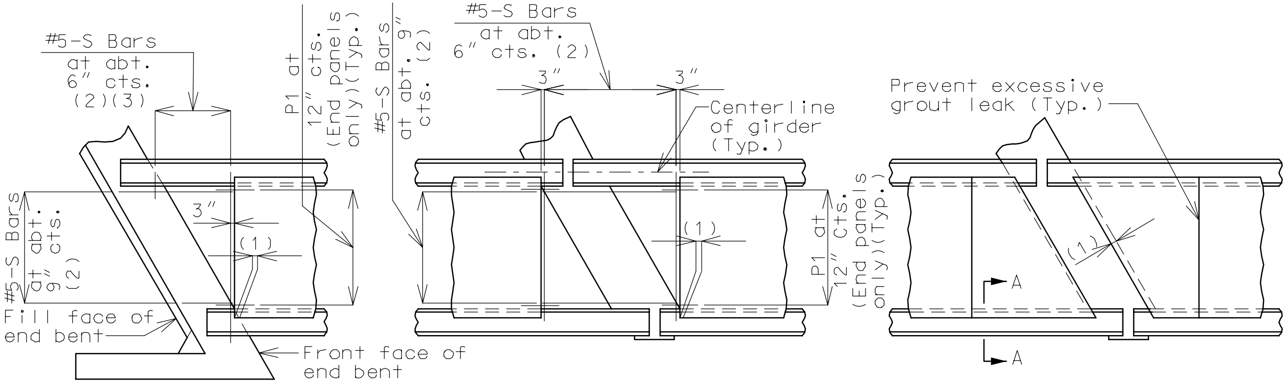
Where:
Δf_{pI} = Initial loss of prestress, ksi
Δf_{pT} = Total loss of prestress, ksi
Δf_{pES} = Loss due to elastic shortening, ksi
Δf_{pSR} = Loss due to shrinkage between transfer and deck placement, ksi
Δf_{pCR} = Loss due to creep between transfer and deck placement, ksi
Δf_{pR1} = Loss due to relaxation of strand between time of transfer and deck placement, ksi
Δf_{pR2} = Loss due to relaxation of strand between deck placement and final time, ksi
Δf_{pSD} = Loss due to shrinkage of girder between deck placement and final time, ksi
Δf_{pCD} = Loss due to creep of girder between deck placement and final time, ksi
Δf_{pSS} = Loss due to shrinkage of deck composite section, ksi

Load Combinations for Stress Checks

LRFD 5.14.1.2.1	*Transportation and Erection Loading = 1.5 x Self Weight of Panel with Initial Prestressing Force*
LRFD TABLE 5.9.4.1.2.1-1	Allowable Concrete Tensile Stress = -0.24 $\sqrt{f'_{ci}}$
LRFD 5.9.4.1.1	Allowable Concrete Compressive Stress = 0.6f'_{ci}
LRFD 9.7.4.1	*Construction Loading = DC + 0.050 ksf with Effective Prestressing Force*
LRFD TABLE 5.9.4.2.2-1	Allowable Concrete Tensile Stress = -0.19 $\sqrt{f'_c}$
LRFD TABLE 5.9.4.2.1-1	Allowable Concrete Compressive Stress = 0.6f'_c
	Service I = Permanent Loads with Effective Prestressing Force
LRFD TABLE 5.9.4.2.1-1	Allowable Concrete Compressive Stress = 0.45f'_c
	Service I = Live Load + Half the Sum of Permanent Loads and Effective Prestressing Force
LRFD 5.9.4.2.1-1	Allowable Concrete Compressive Stress = 0.40f'_c
LRFD TABLE 3.4.1-1	*Service I = 1.0DC + 1.0DW + 1.0LL with Effective Prestressing Force*
LRFD TABLE 5.9.4.2.1-1	Allowable Concrete Compressive Stress = 0.6f'_c
LRFD TABLE 3.4.1-1	*Service III = 1.0DC + 1.0DW + 0.8LL with Effective Prestressing Force*
LRFD TABLE 5.9.4.2.2-1	Allowable Concrete Tensile Stress = -0.19 $\sqrt{f'_c}$
LRFD TABLE 3.4.1-1	*Strength I = 1.25*DC + 1.5*DW + 1.75LL with Effective Prestressing Force*
LRFD 5.7.3.2.3	Factored Moment Resistance = $\phi M_n = A_{ps} f_{ps} (d_p - a/2)$
	Where: ϕ = 1.0, (LRFD 5.5.4.2.1)
	Reinforcement Check
LRFD 5.7.3.3.1	Maximum Requirement = $c/d_e \leq 0.42$
LRFD 5.7.3.3.2	Minimum Requirement = $\phi M_n \geq Min.[1.2M_{cr}, 1.33M_u]$

2.2 Standard Details

Details of Precast Prestressed Panels
Prestressed Structure:
Prestressed Panels



PANELS-SQUARED ENDS

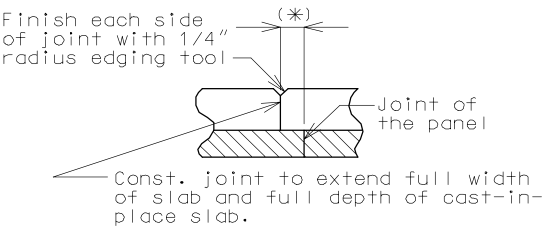
PANELS-SKEWED ENDS

PLAN OF PRECAST PRESTRESSED PANELS PLACEMENT

(1) End panels shall be dimensioned 1" min. to 1-1/2" max. from the inside face of diaphragm.

(2) S-Bars shown are bottom steel in slab between panels and used with squared end panels only.

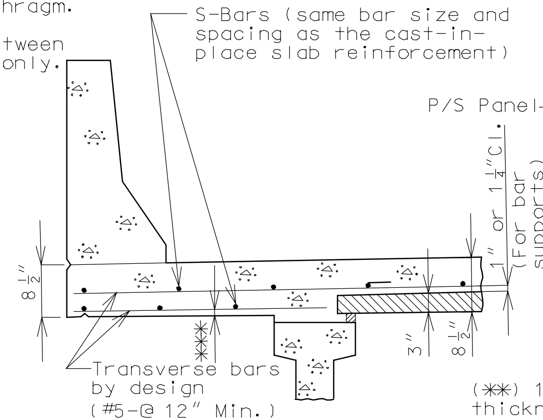
(3) Extend S-Bars 18 inches beyond the front face of end bents only.



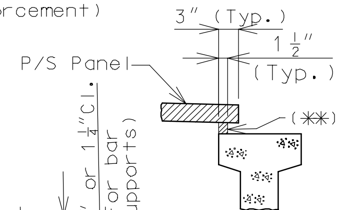
SECTION THRU CONST. JOINT

✱ Adjust the permissible construction joint to a clearance of 6 inches minimum from the joints of the panels.

Note: All reinforcement other than prestressing strands shall be epoxy coated.



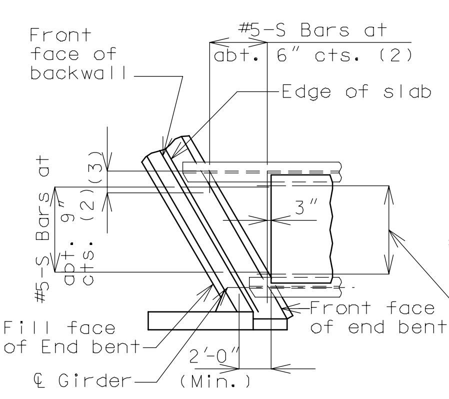
SECTION THRU CANTILEVER



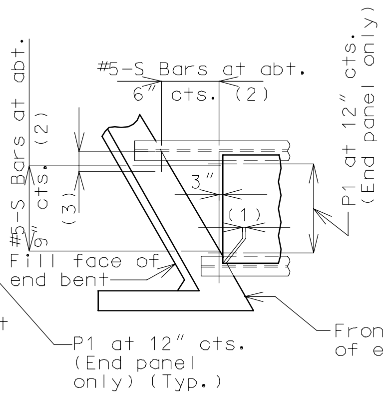
SECTION A-A

(✱✱) 1" Min. thru 2" max. thickness and 1-1/2" width of preformed fiber expansion joint material or polystyrene bedding material

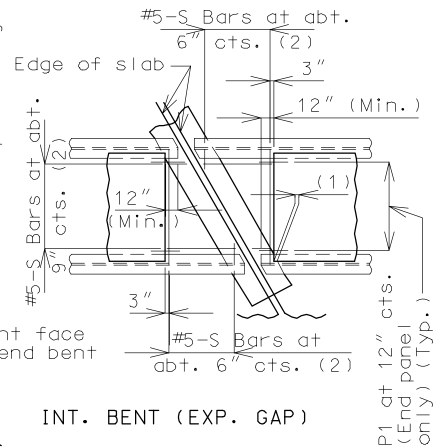
Details of Precast Prestressed Panels
Steel Structure:



END BENT



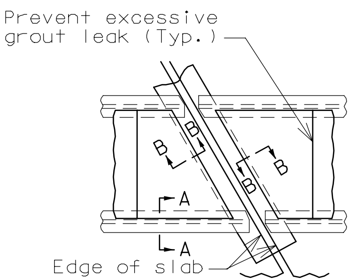
END BENT (INTEGRAL)



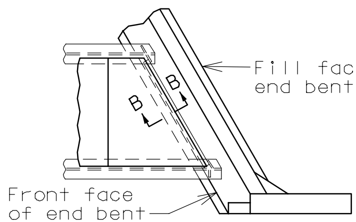
INT. BENT (EXP. GAP)

PANELS-SQUARED ENDS

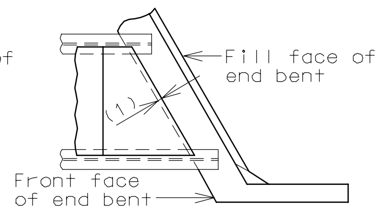
(1) End panels shall be dimensioned 1" min. to 1-1/2" max. from the inside face of diaphragm.
(2) S-Bars shown are bottom steel in slab between panels and used with squared end panels only.
(3) Extend S-bars 18 inches beyond the front face of end bents only.



INT. BENT (EXP. GAP)



END BENT



END BENT (INTEGRAL)

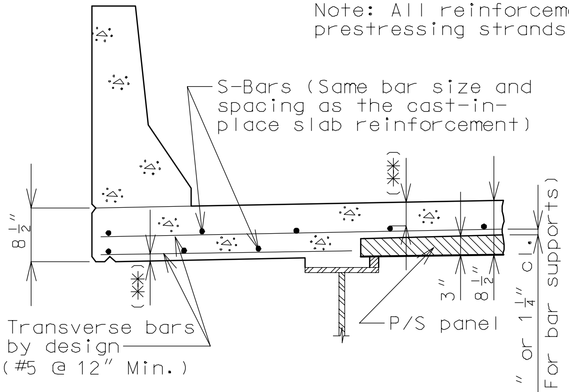
PANELS-SKEWED ENDS

Note: For details of section A-A & B-B, see page 2.2-3.

PLAN OF PRECAST PRESTRESSED PANELS PLACEMENT

Details of Precast Prestressed Panels
Steel Structure: (Cont.)

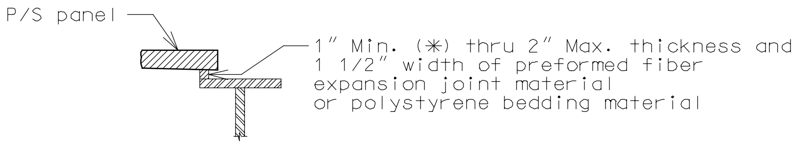
Note: All reinforcement other than prestressing strands shall be epoxy coated.



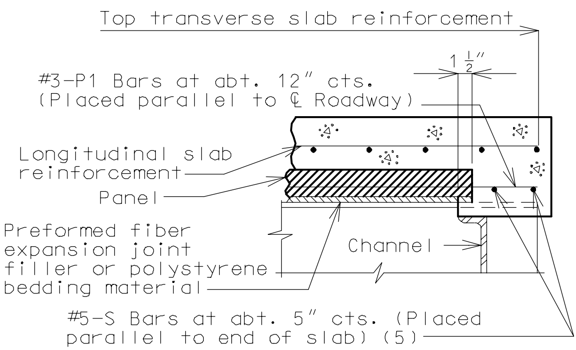
SECTION THRU CANTILEVER

(*) Over splice plates, 3/4" Min. thickness allowed.

(**) See LRFD DG Sec. 3.30.1.5-6



SECTION A-A

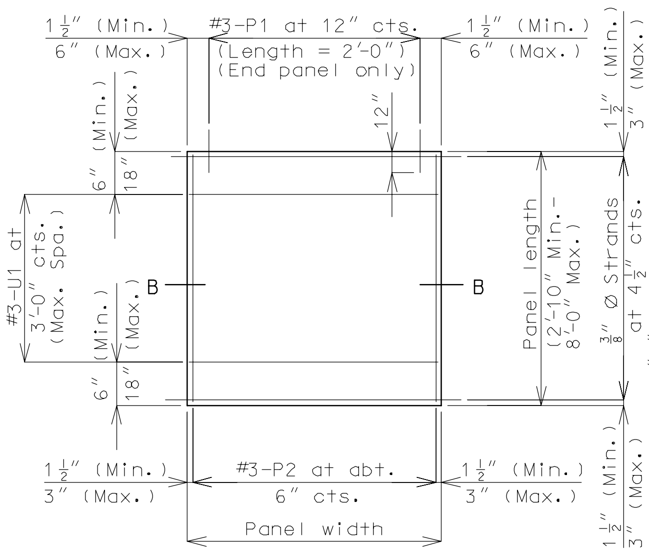


PART SECTION B-B

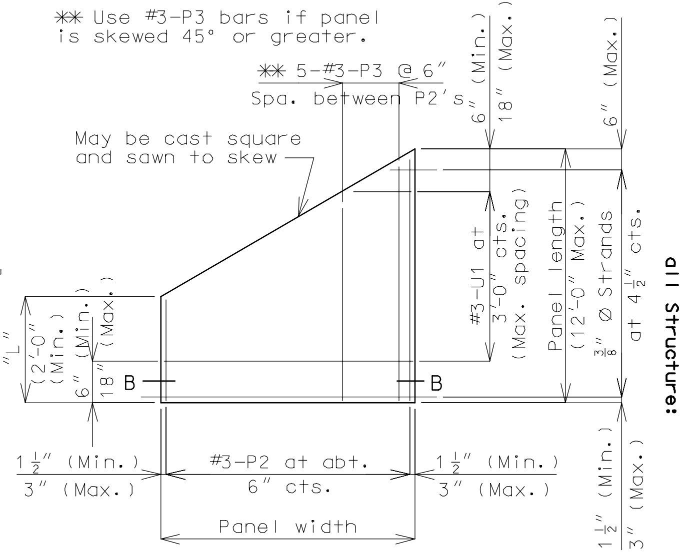
(5) S-Bars shown are used with skewed end panels, or square end panels of square structures only. The #5-S Bars will extend the width of slab (30" lap if necessary) or to within 3" of expansion device assemblies.

Note: For location of section A-A & B-B, LRFD DG Sec. 3.30.2.2-2

Details of Precast Prestressed Panels all Structure:

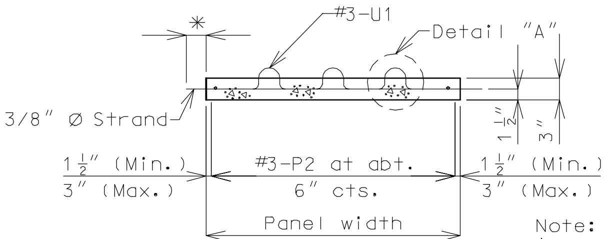


PLAN OF PRECAST PRESTRESSED PANEL

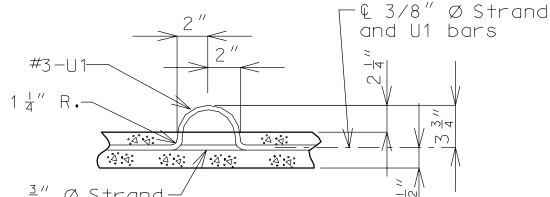


PLAN OF PRECAST PRESTRESSED PANEL (SKEWED END-OPTIONAL)

* = 3" Min. (Typ.) 6" Max. (Typ.) for steel girder structures
* = 6" (Typ.) for P/S girder structures



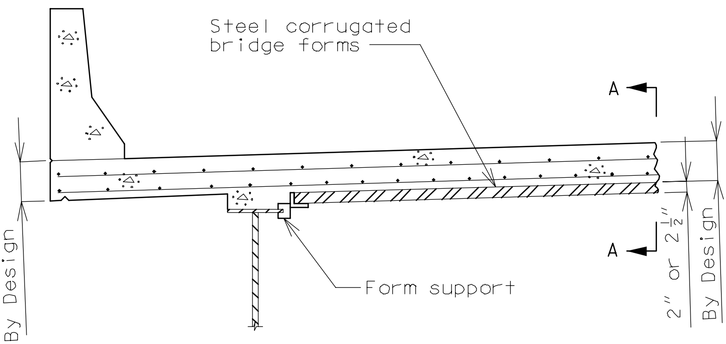
SECTION B-B



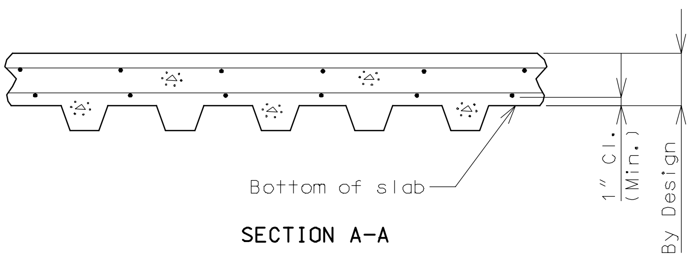
DETAIL "A"

Note:
Area of Strand = Astra = 0.085 sq. in./strand
Initial prestressing stress = fsi = (0.75)(270 ksi) = 202.5 ksi
Initial prestressing force = Astra x fsi
= (0.085 sq. in./strand)(202.5 ksi) = 17.2 kips/strand

2.3 STAY-IN-PLACE FORMS (CURVED STEEL STRUCTURES ONLY)
(Use only with approval of the Structural Project Manager)



STEEL GIRDERS



SECTION A-A

3.1 Slab Drains

Slab Drain Type

Slab drains shall be 8" x 4" x 1/4" steel tubing whenever possible.

Alignment

All standard crown roadways shall have the 8" x 4" steel tubing placed with the 8" side perpendicular to the curb whenever possible.
All super-elevated roadways shall have the 8" x 4" steel tubing placed with the 8" side parallel to the curb.

Slab Drain Spacing

Slab drain spacing shall be designed according to the 1986 FHWA report "Bridge Deck Drainage Guidelines" along with information acquired from the 1995 University of Missouri Rolla report "Scupper Interception Efficiency."

General Requirements for Location and Spacing of Slab Drains

1) Drains shall be spaced no closer than 8 ft. center to center.
2) Drains shall be omitted on high side of super-elevation bridges.
3) Drains shall not be located over unprotected fill. If drains are needed, fill should be protected with use of; rock blanket with surface grout, rock blanket with type 3 qeotextile, or concrete slope protection.
4) Drains shall be omitted on all grade separations and rail overpasses except when located over concrete slope protection or as noted on Design Layout.
5) For Bridges with slopes less than 0.5%, space drains at about 10 ft. centers where possible.
6) Use consistent spacing for drains when possible.
7) Drains shall be placed at least 5 feet from the face of substructure beam.
8) Drains shall be dimensioned along centerline of exterior girder to facilitate placement of coil inserts or holes in girders.
9) For all sag vertical curves, locate the points at which the slope is 0.5% on either side of the low point, and space drains on 10 ft. centers between them where possible. Use equations in this section for spacing drains for the remainder of the curve.
10) If location restrictions apply, the same number of drains as calculated by equations in this section shall be placed on the bridge when possible. The designer is responsible for relocating drains.
11) The length of the approach slab shall be included in the length of the bridge for spacing computations. Do not place slab drains on the approach slab.

Calculation of spacing to first slab drain

The first slab drain either side from the high point of the bridge shall be calculated according the following equation. If the value of L_1 is greater than the bridge length, slab drains are not required.

FHWA equation (4)

$$L_1 = \frac{24{,}393.6(S_x)^{1.67}(S)^{0.5}(T)^{2.67}}{CnIW}$$

- L_1 = Distance from high point to first slab drain (ft.)
- S_x = Cross slope of slab (ft./ft.)
- S = Longitudinal slope of bridge (ft./ft.). For vertical curve bridges, "S" is the longitudinal slope at the location of the drain being analyzed. A linear approximation can be used to simplify the calculations.

- T = Design spread (ft.). The spread is the width of gutter flow. The spread for any bridge with a 3 ft. or more shoulder width should be taken as 6 ft. If the shoulder width is less than 3 ft., the spread shall be the shoulder width plus 3 ft.
- C = Ratio of impervious to pervious drain area. On a bridge deck, most rainfall runs off, except at the beginning of a storm when rain wets the bridge deck and fills small depression areas. Design of slab drain spacing assumes the bridge deck is wetted, therefore a " C " value of 1.0 is recommended.
- n = Manning's coefficient of friction. For typical pavements, "n" equal to 0.016 is used.
- I = Design rainfall intensity (in./hr.). The "Rational Method" as outlined in "Hydraulic Engineering Circular-12, (HEC-12)" with a 25 year frequency for a 5 minute time period shall be used to calculate the design rainfall. Missouri's intensity varies from 8.00 in./hr. to 8.50 in./hr. for this frequency and time period. Therefore an "I" value of 8.50 in./hr. is recommended to determine slab drain spacing.
- W = Width of deck drainage area (ft.). For crowned roadways use distance from top of crown to curb face and for super-elevated bridges use distance from face of curb to face of curb.

Calculation of Additional Slab Drain Spacing

Once the first slab drain has been located, slab drain efficiency "Es" is required to determine the location of additional slab drains. Given the efficiency of the slab drain, the amount of flow intercepted by the first slab drain $(q)_i$ is determined by $(q)_i = Es(Q_T)_i$ where (Q_T) is the flow at which the gutter is filled to the design spread (T) at slab drain #1 and is determined by the equation $Q_T = \frac{CIWL}{43{,}560}$ (cu. ft./second)

Interception flow decreases the flow in the gutter by q (intercepted). This flow must be replaced before another slab drain is required. Flow in the gutter at the second slab drain is given by the equation

$$(Q_T)_{i+1} = \frac{CIW(L)_{i+1}}{43{,}560} - \sum_{j=1}^{i}(q)_j \quad \text{(cu. ft./second)}$$

Another slab drain is located when runoff minus intercepted flow equals flow in the gutter filled to the design spread (T) at length $(L)_{i+1}$ where $(L)_{i+1}$ is the total length of bridge to $(\text{slab drain})_{i+1}$.

For tangent sections the additional theoretical slab drain spacing are constant. For vertical curve sections the theoretical slab drain spacing are variable and require the designer to repeat the process till the end of the bridge. Theoretical spacing should be revised to consider ease of spacing.

Calculation of Slab Drain Interception Efficiency

Slab drain interception efficiency (E_S) is that fraction of gutter flow removed by the slab drain. FHWA's report called "Bridge Deck Drainage Guidelines" gives an approximation for (E_S) for small grates and low gutter velocities,

$E_S = 1-[1-(w/T)]^{2.67}$ which is a fraction of triangular gutter flow passing over a slab drain located next to the curb.

- w = width of slab drain normal to the flow (ft).
- T = Design spread.

In UMR's report "Scupper Interception Efficiency" imperical data is used to determine a more precise efficiency coefficient. They state that the slab drain efficiency (E_S) can be closely approximated by the equation $E_S=aS^b$, where E_S is a percent (%) and must be divided by 100 for use in the flow equations.

- S = Longitudinal slope of bridge at slab drain location.
- a and b = Imperical coefficients dependent on the bridge cross-slope. The following tables can be used to determine a and b.

The UMR method shall be used whenever possible because of its ability to account for increased velocities with increased slopes in its efficiency coefficient. When the design spread "T" is other than 6 feet, the FHWA method must be used.

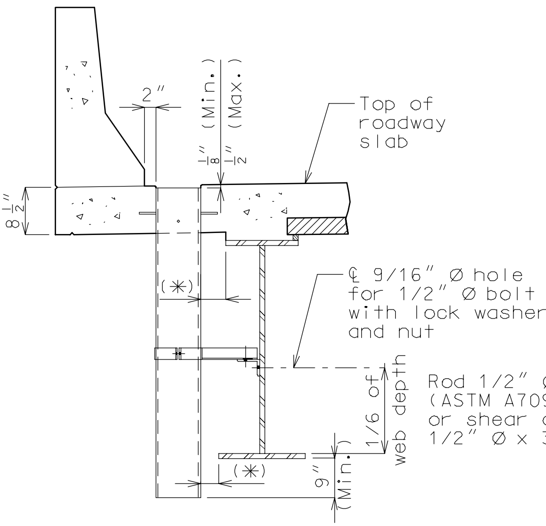
Slab Drain with 8" dimension perpendicular to face of curb. T = 6 ft.

Cross-Slope	a	b
0.010	14.580	-0.180
0.016	6.670	-0.340
0.020	3.550	-0.450
0.030	2.080	-0.500
0.040	2.080	-0.440
0.050	3.680	-0.280
0.060	5.510	-0.140
0.070	4.550	-0.160
0.080	5.420	-0.110

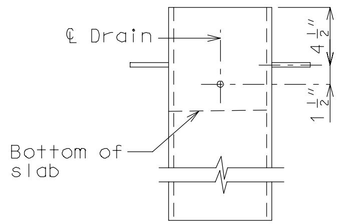
Slab Drain with 8" dimension parallel to face of curb. T = 6 ft.

Cross-Slope	a	b
0.010	9.170	-0.230
0.016	7.060	-0.280
0.020	5.620	-0.320
0.030	4.670	-0.320
0.040	3.060	-0.370
0.050	3.660	-0.300
0.060	4.560	-0.210
0.070	5.500	-0.130
0.080	5.420	-0.110

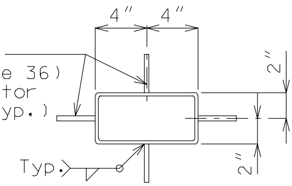
3.2 SLAB DRAINS (CONT.)
STEEL STRUCTURE - NO WEARING SURFACE



PART SECTION OF SLAB AT DRAIN

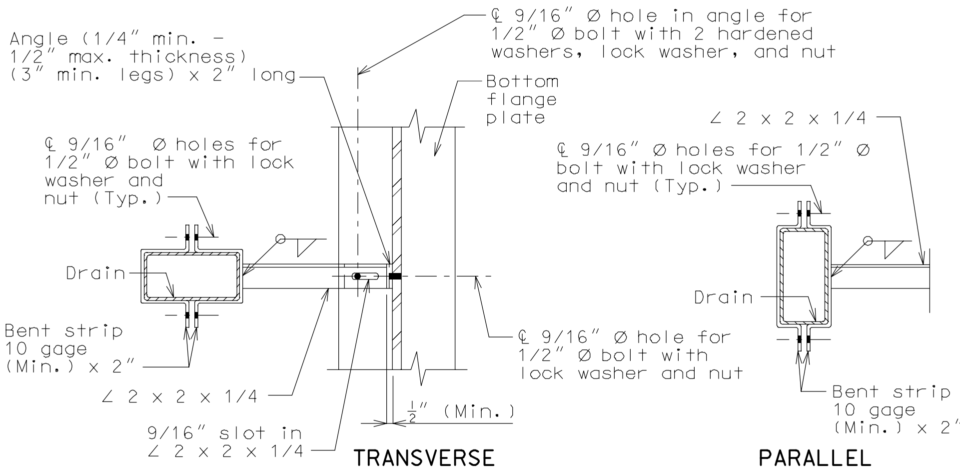


ELEVATION OF DRAIN



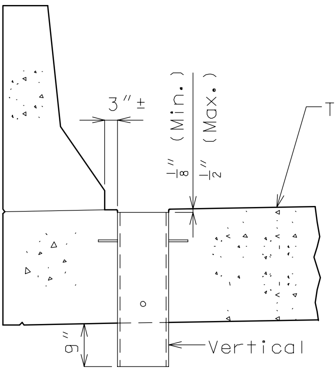
PLAN OF DRAIN

(*) If dimension is less than 1″, drains shall be placed parallel to roadway. Otherwise, place drains transverse to roadway.

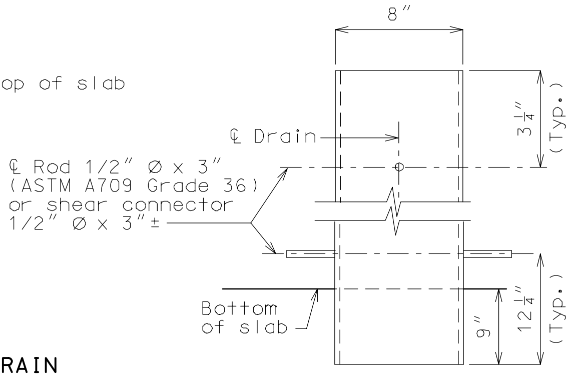


PART PLANS SHOWING BRACKET ASSEMBLY

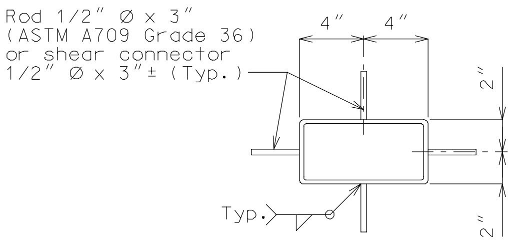
SLAB DRAINS (CONT.)
CONTINUOUS CONCRETE STRUCTURE - NO WEARING SURFACE



PART SECTION OF SLAB AT DRAIN



ELEVATION OF DRAIN

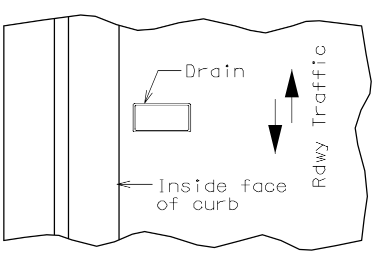


PLAN OF DRAIN

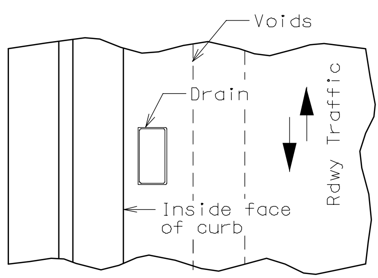
Notes:

Drains shall be placed a minimum of 6″ from leg of all drop panel reinforcing bars.

(✳) Also see page 3.1-1 of this section and check with Structural Project Manager.



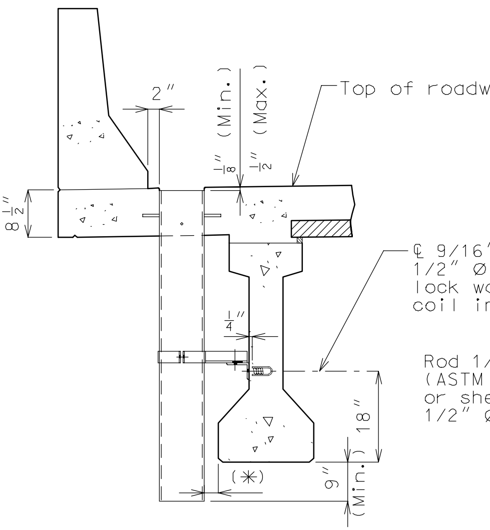
SOLID SLAB BRIDGE



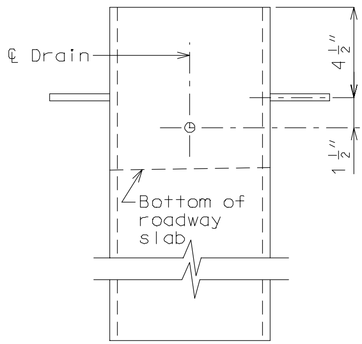
VOIDED SLAB BRIDGE

PART PLAN OF SLAB AT DRAIN (✳)

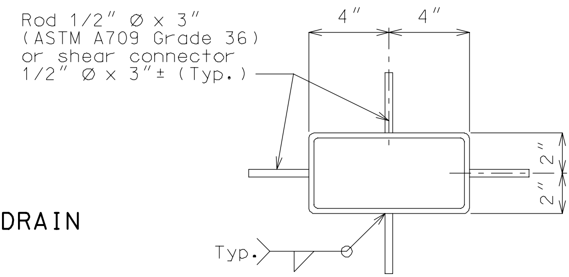
SLAB DRAINS (CONT.)
PRESTRESSED "I" GIRDER STRUCTURES
NO WEARING SURFACE



PART SECTION OF SLAB AT DRAIN

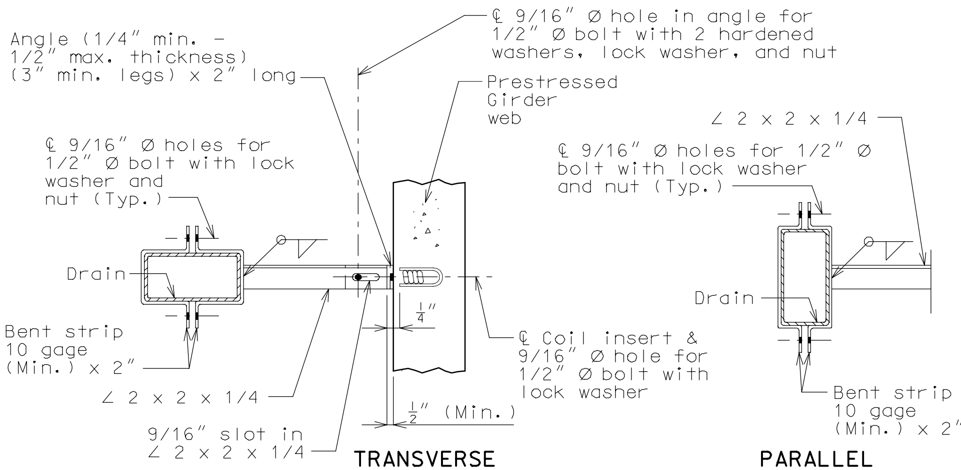


ELEVATION OF DRAIN



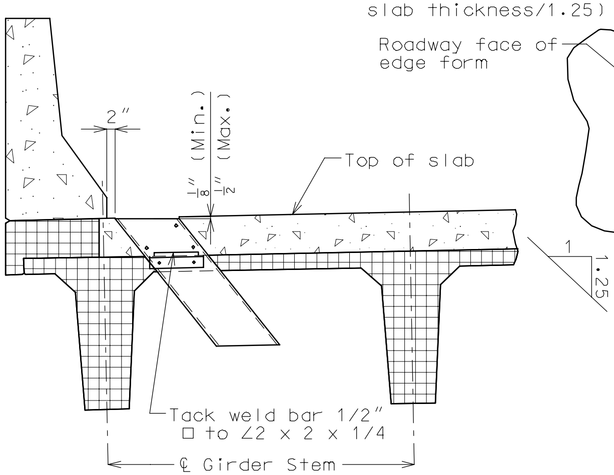
PLAN OF DRAIN

(✱) If dimension is less than 1", drains shall be placed parallel to roadway.
Otherwise, place drains transverse to roadway.

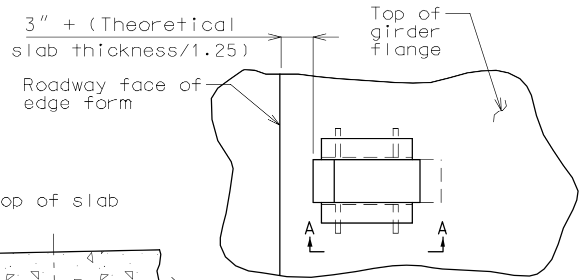


PART PLANS SHOWING BRACKET ASSEMBLY

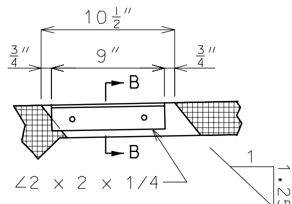
SLAB DRAINS (CONT.)
PRESTRESSED DOUBLE-TEE STRUCTURES
NO WEARING SURFACE



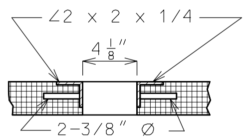
PART SECTION OF SLAB AT DRAIN



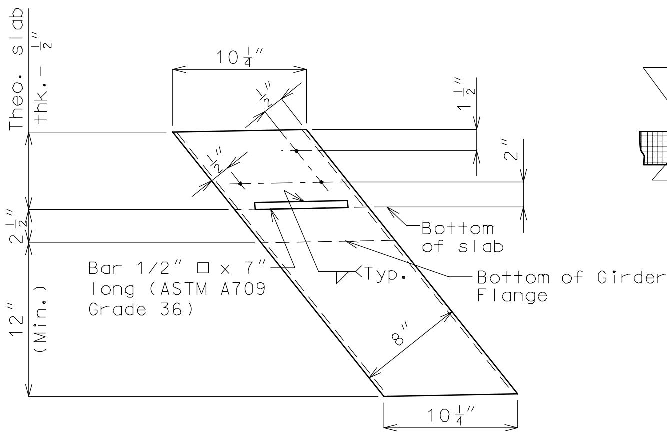
PART PLAN OF DRAIN BLOCKOUT



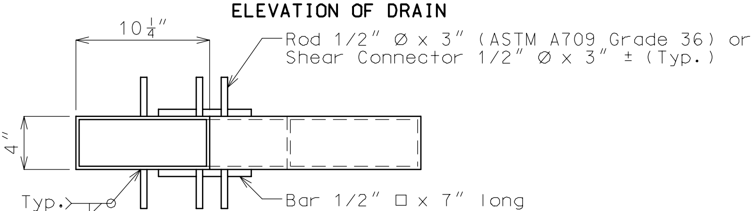
PART SECTION A-A



SECTION B-B

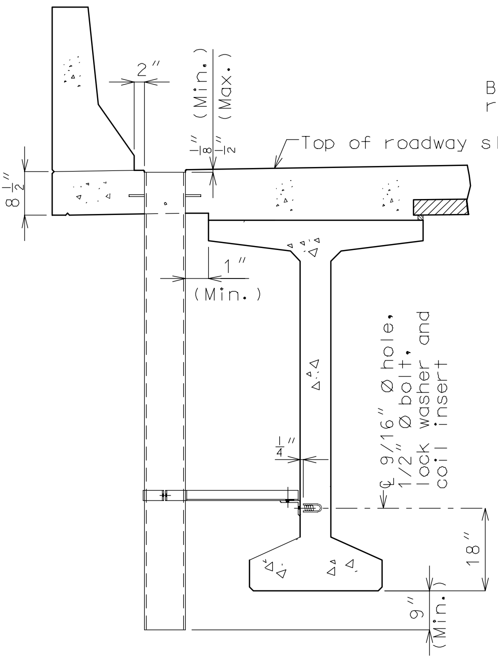


ELEVATION OF DRAIN

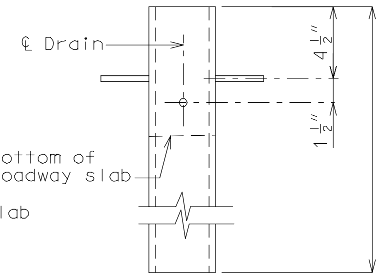


PLAN OF DRAIN

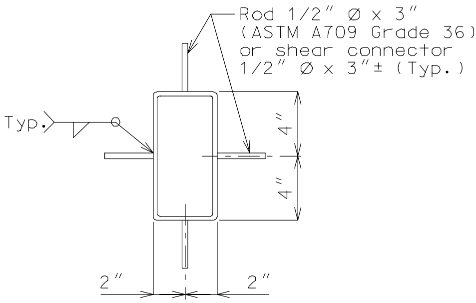
SLAB DRAINS (CONT.)
PRESTRESSED BULB TEE GIRDER STRUCTURES
NO WEARING SURFACE
CANTILEVERS 3'-8" OR MORE



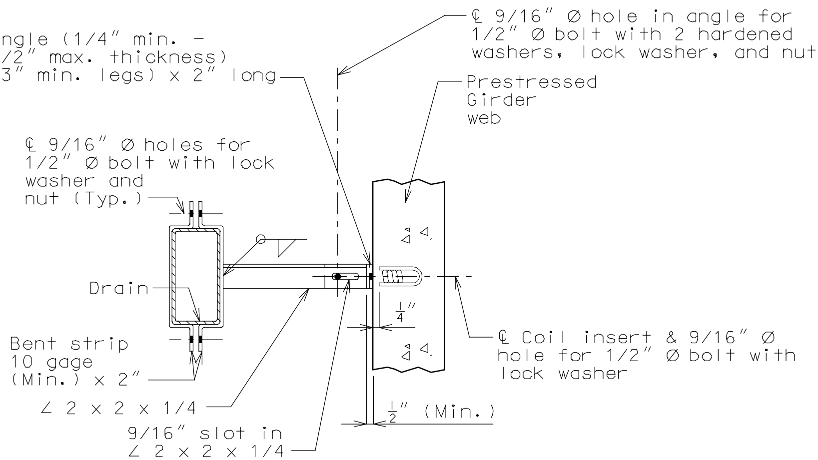
PART SECTION OF SLAB AT DRAIN



ELEVATION OF DRAIN

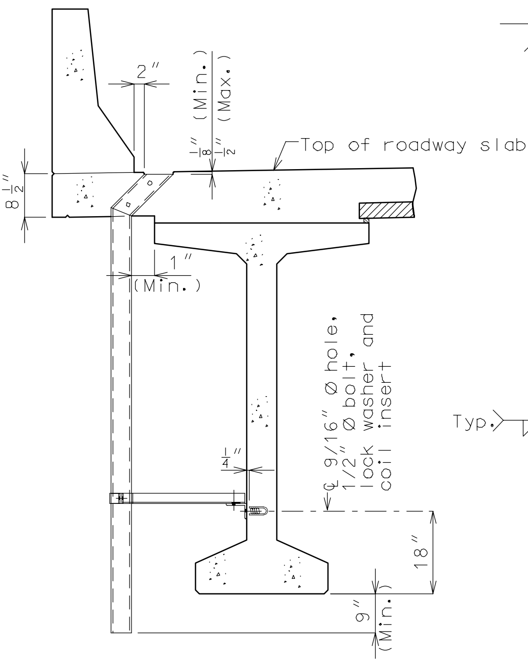


PLAN OF DRAIN

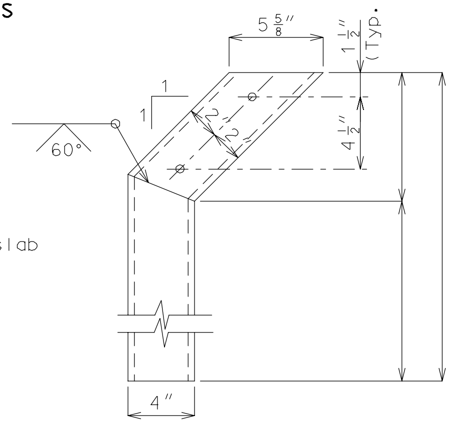


PART PLANS SHOWING BRACKET ASSEMBLY

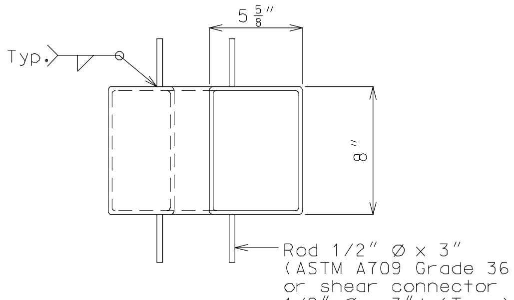
SLAB DRAINS (CONT.)
PRESTRESSED BULB TEE GIRDER STRUCTURES
NO WEARING SURFACE
CANTILEVERS LESS THAN 3'-8"



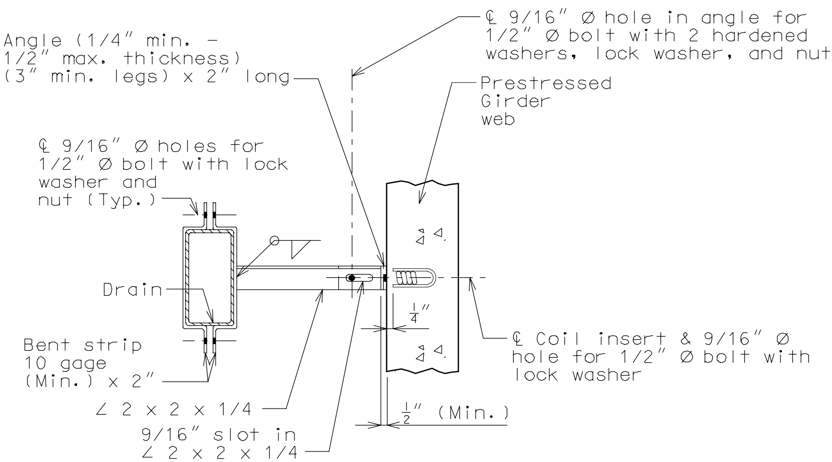
PART SECTION OF SLAB AT DRAIN



ELEVATION OF DRAIN

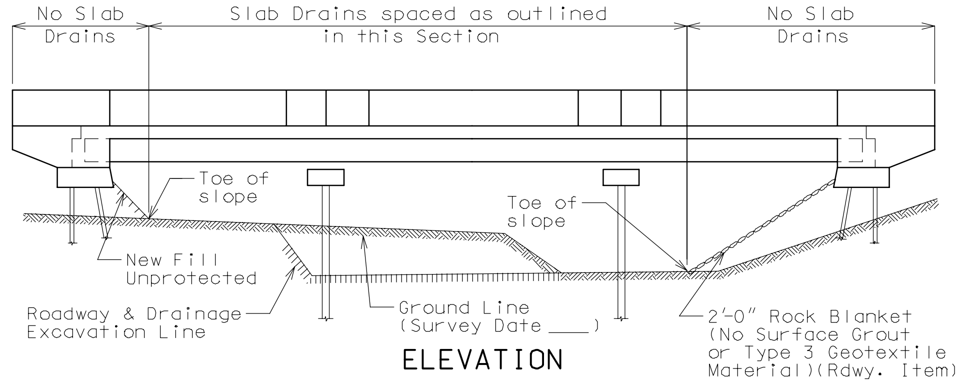


PLAN OF DRAIN

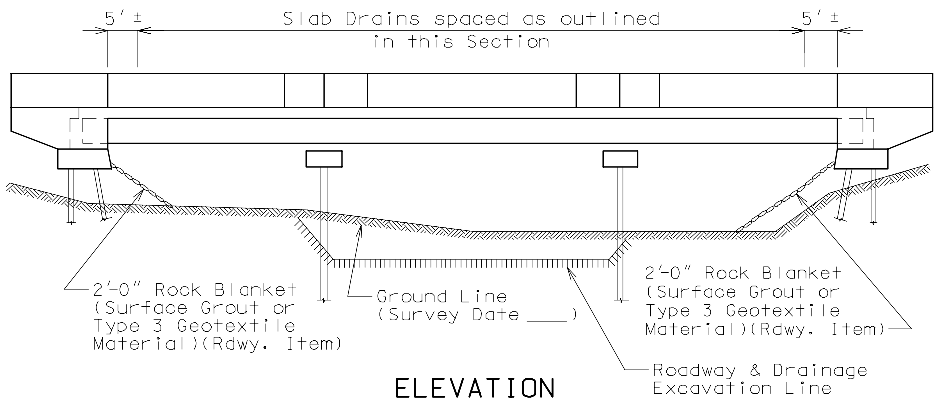


PART PLANS SHOWING BRACKET ASSEMBLY

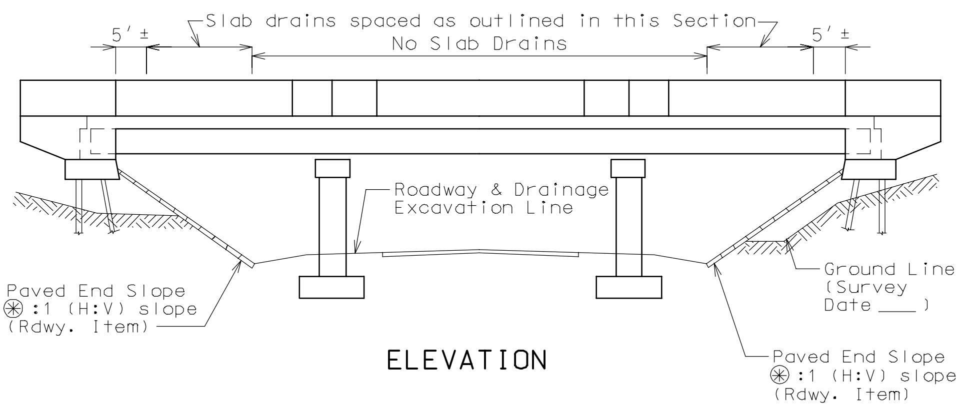
3.3 SLAB DRAINS (CONT.)
GENERAL REQUIREMENTS FOR LOCATION OF SLAB DRAINS



ELEVATION



ELEVATION



ELEVATION

⊛ See Design Layout for maximum slope of spill fill.

4.1 CONDUIT SYSTEMS

General

Conduit systems shall be provided on structures when specified on the Design Layout.

All Conduit shall be rigid non-metallic schedule 40 heavy wall PVC (Polyvinyl Chloride Plastic). See LRFD DG Sec. 4 pages H4-A1 and H4-A2 for appropriate notes.

All Conduit Clamps, if required, shall be commercially available conduit clamps approved by the engineer.

Size

Conduit size shall be specified on the Design Layout.

Location

Single 2″ round conduit shall be placed in the slab.
Single conduit greater than 2″ round shall be placed in the barrier curb (4″ Ø max. for bridge without cantilever sidewalk, 3″ Ø max. for bridge with cantilever sidewalk).
Placement of multiple conduit shall be determined on a case by case basis. Options include placing conduit on hangers, encasing conduit in concrete that is attached to slab, and encasing conduit in safety barrier curb if there is enough room. Multiple conduits are not allowed in curb when sidewalk is used.
See page 4.1-2 for example details.

Expansion Fittings

Expansion fittings shall be specified on the plans when conduit passes across expansion devices and filled joints, including filled joints in the barrier curb when conduit is located in the curb.

Expansion movements shall be specified at each location of an expansion fitting. Expansion fittings shall be able to accommodate movement 1-1/2 times the designed expansion movement or 4 times the joint filler thickness rounded to nearest half inch.

Example 1 - Plate Girder with expansion length of 300 ft.
Δ(Steel) = (0.0000065)(140)(300)(12) = 3.276 inches
Δ(Fitting)total = 1.5 x 3.276 = 4.914inches
Δ(Fitting)either direction = (4.914/2) = 2.457 inches
Use 2-1/2 inches in note H4.7.

Example 2 - 1/4″ Joint filler in curb
Δ(Fitting)total = 4 x 0.25 = 1.0 inch
Δ(Fitting)either direction = (1.0/2) = 0.5 inch
Use 1/2 inch in note H4.7.

Junction Boxes

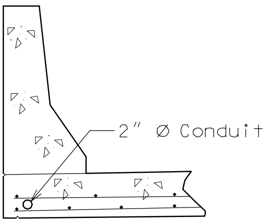
Size and location of junction boxes shall be specified on the plans when a conduit system is used. The minimum size junction box for 2″ round conduit is 12″ x 12″ x 4″. The minimum size junction box for greater than 2″ round conduit is 12″ x 14″ x 6″. The minimum size junction box for 4″ Ø round conduit is 16″ x 12″ x 6″. No more than one 4″Ø conduit shall be allowed in safety barrier curb and none are allowed when cantilever sidewalk is used due to clearance problems with reinforcement and inadequate concrete cover. Multiple conduits are not allowed in safety barrier curb when cantilever sidewalk is used. A junction box shall be located in a wing at each end of the bridge. Junction boxes shall also be located on the bridge when junction box spacing is greater than 250 feet. Junction boxes located in the slab or barrier curb shall preferably be located in areas accessible from underneath the bridge. See Page 4.1-3 for details of locations of junction boxes.

CONDUIT SYSTEMS PLACEMENT

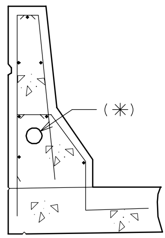
(✳) Use 2″ Ø or 3″ Ø conduit for bridges with sidewalk;
Use 4″ Ø (Max.) conduit for bridge without sidewalk.

(✳✳) Multiple conduits are not allowed when sidewalk is used.

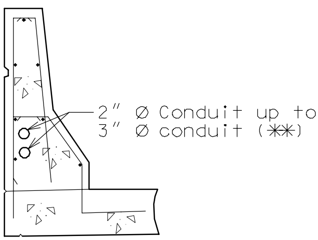
4″ Ø conduit not allowed in curb when sidewalk not supported by girder is used.



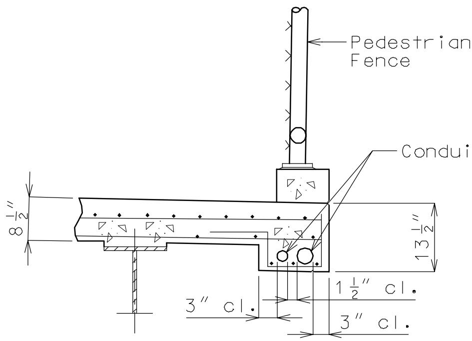
SECTION OF CONDUIT IN SLAB



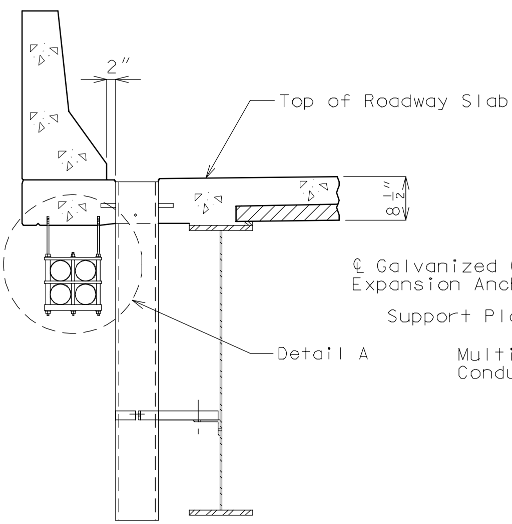
SECTION OF CONDUIT IN BARRIER CURB

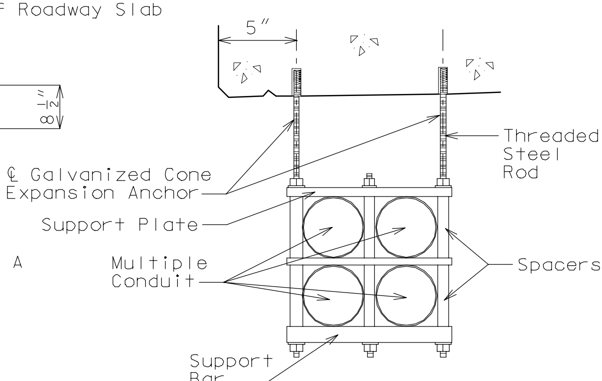


SECTION OF MULTIPLE CONDUIT IN BARRIER CURB



SECTION OF MULTIPLE CONDUIT ENCASED IN SLAB

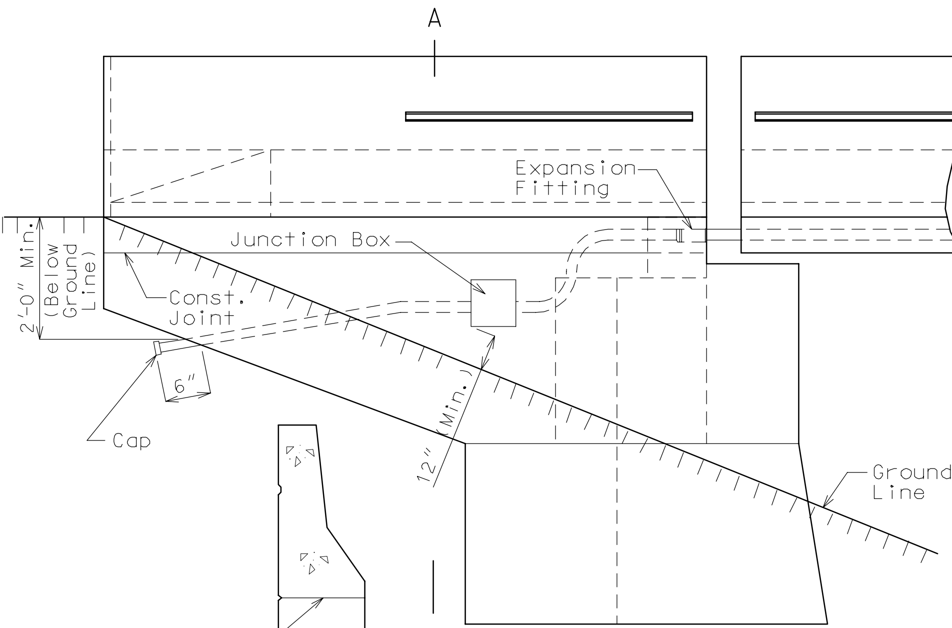




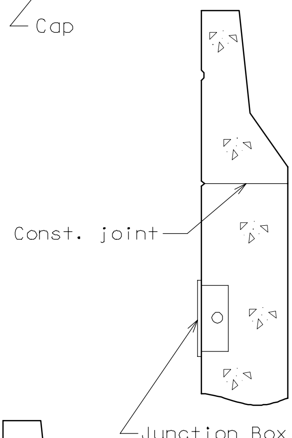
DETAIL A

PART SECTION OF SUSPENDED CONDUIT AT DRAIN

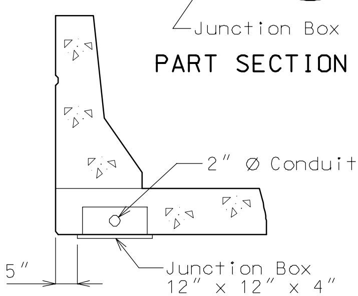
DETAILS OF JUNCTION BOXES



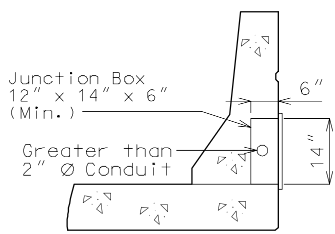
PART ELEVATION OF JUNCTION BOX IN WING



PART SECTION A-A



SECTION OF JUNCTION BOX IN SLAB



SECTION OF JUNCTION BOX IN BARRIER CURB

(Note: if multiple conduits, 4" Ø conduit not allowed in curb.)